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An assessment was made of a time and wage incentive program for solid waste collection and supervisory personnel in the test city, Covington, Kentucky. On an annualized basis, cost savings amounting to $113,000 (19 percent of budget) resulted from implementation of the new program. The major areas of research included an assessment of union/management/worker behavioral attitudes, construction of a solid waste generation/collection computerized data bank, development of work standards utilizing work measurement techniques, application of time standards to area route development, and design of a prototype wage incentive program based on area routes with known work content. Political considerations and the inherent characteristics of municipal government organization were identified as major constraints to effective management of solid waste collection operations and cost reductions.

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WAGE INCENTIVES FOR SOLID WASTE COLLECTION PERSONNEL

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FOREWORD

The Environmental Protection Agency was created because of increasing public and government concern about the dangers of pollution to the health and welfare of the American people. Noxious air, foul water, and spoiled land are tragic testimony to the deterioration of our natural environment. The complexity of that environment and the interplay between its components require a concentrated and integrated attack on the problem.

Research and development is that necessary first step in problem solution and it involves defining the problem, measuring its impact, and searching for solutions. The Municipal Environmental Research Laboratory develops new and improved technology and systems for the prevention, treatment, and management of wastewater and solid and hazardous waste pollutant discharges from municipal and community sources, for the preservation and treatment of public drinking water supplies, and to minimize the adverse economic, social, health, and aesthetic effects of pollution. This publication is one of the products of that research; a most vital communications link between the researcher and the user community.

This project examines the feasibility of using incentives to increase productivity of solid waste personnel. The results show that incentives are technically feasible and that substantial cost savings can be realized. Hopefully, the findings reported herein will be valuable in assisting local governments to increase the productivity of their solid waste collection workers.

Francis T. Mayo, Director
Municipal Environmental
Research Laboratory

ABSTRACT

The purpose of this project is to determine the feasibility of incentive programs for municipal solid waste collection personnel. Major research areas include an assessment of union/management/worker behavioral attitudes towards wage incentives; construction of a solid waste generation/collection computerized data bank; development of work standards utilizing work measurement techniques; application of time standards to area route development; design of a prototype wage incentive program based on area routes with known work content; and assessment of the impact of an incentive program in the test City of Covington, Kentucky.

The findings show that wage incentive programs for municipal solid waste personnel are feasible and technically possible, but that political problems more complex than found in private industry must be dealt with. Substantial cost savings may be realized through proper design and implementation of time and monetary incentive programs. In the test City, annual savings of $113,000 (19 percent of budget) resulted from implementation of a new collection system utilizing time incentives. An additional $112,000 (making a total of $225,000 or 38 percent of budget) savings resulted from a second implementation with collection frequency reduced from twice to once weekly.

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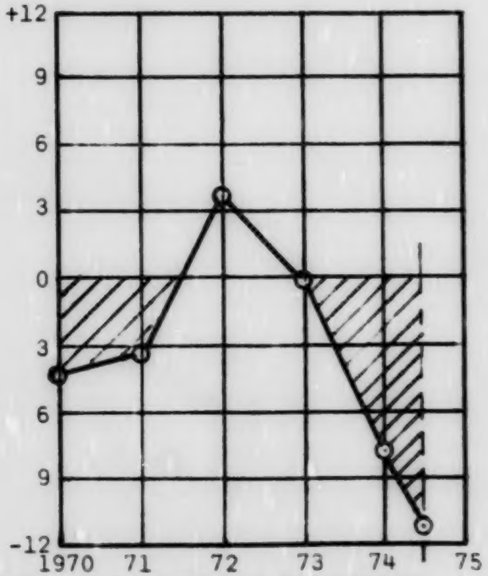
1 OVERVIEW AND BACKGROUND

SUMMARY AND CONCLUSIONS

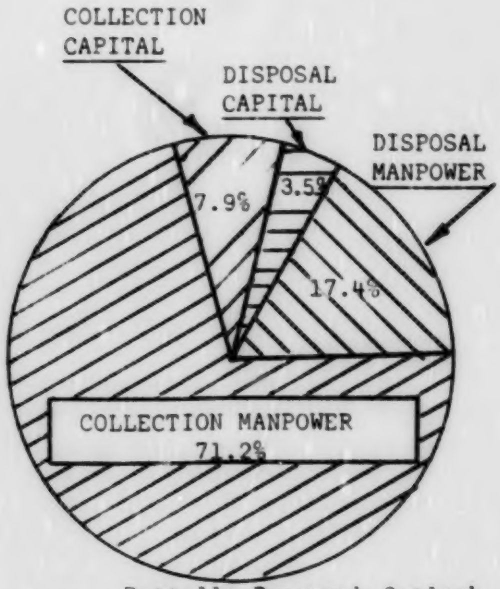
Introduction

Municipal governments, caught in the continuing squeeze of inflation, must provide labor-intensive services from a relatively fixed income base. The magnitude of the problem is illustrated by recent Commerce Department data as shown in Figure 1. The collection of solid waste is a major municipal function offering manifold opportunities for productivity improvement. Historically, collection has been characterized by high manpower costs. Typically, about three-fourths of solid wastes costs are required for collection labor (Figure 2).



Source: U.S. Commerce Department

FIGURE 1. STATE AND LOCAL GOVERNMENT BUDGET SURPLUS/DEFICITS



Source: Battelle Research Outlook Volume 3, Number 3

FIGURE 2. A BREAKDOWN OF COSTS TO COMMUNITIES FOR REFUSE HANDLING

While it is predicted that new technology developments will increase waste collection productivity, systems in the foreseeable future will remain highly labor intensive. Dramatic changes that reduce the labor requirement, such as sewer transport of solid wastes, are not likely to occur for some time.* The need is clear for increasing the productivity of human resources.

Objective

One method to increase human productivity is to provide positive incentives for performance. The objective of this project is to determine the feasibility of time and wage incentives for municipal solid waste collection/disposal personnel.

Problem Statement

The problem of developing a wage incentive program for solid waste workers is twofold. The first requirement is technical -- to accurately compute work content for a given collection method. The second aspect is the behavioral problem associated with political constraints, individual motivation and job performance, and human interaction (e.g., citizens, city management, union/workers).

Report Overview

The Report consists of seven major sections. Section 1 provides general background information and an overview. Section 2 addresses wage incentive systems. The Section reviews classical direct wage incentive plans and their current application in industry. Wage incentive programs for public employees in the United States are surveyed, and a prototype incentive program for solid waste workers is structured.

Sections 3 and 4 are concerned with behavioral problems relating to incentives. Section 3 reviews motivation and performance as it relates to job satisfaction, and presents a method for selecting collection crews/teams through sociometric analysis. Section 4 describes personal characteristics of solid waste workers. Causes of absenteeism are identified, and relationships developed between absenteeism and worker demographic characteristics.

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*Albrecht, O.W., and Oberacker, D.A.,"Sewer Transport of Household Refuse, A Replacement For The Refuse Truck," News of Environmental Research in Cincinnati, U.S. Environmental Protection Agency, May 9, 1975.

Section 5 discusses the application of work measurement techniques and the development of time standards for waste collection activities. Section 6 describes the computerized data bank which has been constructed on a stop-by-stop basis for the entire test city. The major computer programs and their capabilities are outlined.

The results of Sections 5 and 6 are utilized in Section 7 to develop waste collection truck area routes. Six alternative truck area route plans with team time incentives have been designed for the test city. Nonmarket and cost-savings comparisons of the six alternative plans are presented. Two implementations are described. The alternative plan first implemented (Alternative III-A) maintained twice-a-week frequency and reduced crew size from three to two workers. The second implementation (Alternative IV) provided once-a-week collection with three-worker crews. Annual savings of the first implementation were approximately $113,000. The second implementation which occurred eight months later, realized an additional $112,000 annual savings ($225,000 total or 38 percent of the original budget).

Conclusions

The following summarizes major conclusions of this project:

1) A wage incentive program for municipal solid waste collection/disposal personnel is feasible and technically possible. In any incentive program, private or government, human maturity and integrity are required of all participating groups. In private industry, the incentive program involves only management and workers/unions while in contrast, municipal government is politically more complex. A multiplicity of groups have vested interests in municipal operations, i.e., the citizens, city commissioners, mayor, city manager, subordinate administrators, and the workers/unions. The management function is usually more diffuse and transitory than in the private sector. No single decision-making authority exists because typically municipalities operate with the triumvirate of the commission, mayor, and city manager. The complexity is further compounded by legislative and civil service restrictions.

2) Increased productivity and substantial cost savings may be realized through proper design and implementation of time and monetary incentive programs. In the test City, annual savings of $113,000 (19 percent of budget) resulted from the new collec-

tion system utilizing time incentives. In addition, business collection services were expanded to a larger number of customers, and a new large item pickup service was added for residential and business customers. The implementation of wage incentives would realize additional cost savings.

3) Management's ability to compute work content is necessary if it is to measure efficiency and to respond effectively to changes influencing waste collection, e.g., changes in collection equipment, method, or frequency. To eliminate the difficulties inherent with using a 'base year' in determining incentives, the ability to compute work content is mandatory.

4) Time-predictive models for work content must be accurate yet flexible and easy to apply if they are to be accepted and implemented on an on-going basis by public works personnel. These models must be based on work measurement analysis of the collection/disposal methods. Historical truck time-out and time-in data is not adequate because they do not necessarily reflect the amount of time spent working.

5) In addition to the work measurement analysis, detailed waste generation information is required for the time-predictive models because of the impact of waste volume on work content. Such detailed information may be obtained either from a waste predictive model or extensive field surveys. Since no adequate waste predictive model is now available, the present investigation required a stop-by-stop field survey.

6) In assignment of collection truck crews, the delineation of route areas is most crucial, i.e., the work content of the route area assigned to an individual truck crew must equal a standard or incentive day.

7) Sequential routing within the assigned area is best accomplished by public works management and collection personnel utilizing their experience and knowledge of the collection areas. Typically, collection areas consist of only a few square blocks, thus easily permitting heuristic design. Also, most motivation and job performance investigations show that workers perform at higher overall productivity levels if they have been involved in some design and planning of their jobs.

Therefore, theoretical modeling of the collection sequence, e.g., the Chinese Postman, Eulerian Tour, and Traveling Salesman algorithms have little practical value.

8) Worker performance will be improved with proper job design and crew selection.

9) Worker job satisfaction will be enhanced with improved motivation and performance.

10) Certain personal and previous experience characteristics indicate worker absenteeism patterns for waste collection, e.g., age, number of dependents, previous illness, and previous employment.

RECOMMENDATIONS FOR FUTURE RESEARCH

The following projects should be considered for future research:

1) The demonstration of wage incentives for waste collection based on collection work content.

2) The development of a prototype technical support system to assist solid waste management in initiating desirable changes. The system would consist of three major elements: First, the establishment of a block-by-block data base, second, the formulation of additional models for predicting collection/disposal work content and overall operating costs, and third, the design and implementation of a management information system to provide on-line capability through computer-linked terminals or mini-computers in the public works offices.

3) The identification of waste generation predictors to forecast the volume of wastes emanating from specific geographic areas on an on-going basis.

4) The development of work standards for various collection methods and equipment with particular emphasis on emerging technologies.

THE SOLID WASTE OPERATING SYSTEM IN COVINGTON, KENTUCKY

The City of Covington, Kentucky, in the Metropolitan Greater Cincinnati area, served as the test city for this project. As a mid-American city with a 1970 Census population of over 50,000, Covington solid waste collection/disposal operation is representative of medium size U.S. cities with respect to methods and equipment, job categories, climate, topography, socioeconomic characteristics, and union-municipal relationships.

Solid waste collection and disposal in Covington is performed by the Solid Waste Division of the Department of Public Works housed in the Municipal Garage (Figure 3). Collection is accomplished by truck crews using rear packers as illustrated in Figures 4 and 5. Citizens are responsible for curbside setout, and typically use cans and bags for containers (Figure 6). Until recently, all solid waste was disposed of at a sanitary landfill in south Covington. In early 1975, the City opened a transfer facility located near the Garage, with final disposal contracted to a neighboring county landfill.

The collection system in operation at the beginning of this project had developed historically with little modification over the past two or three decades. The resultant effect was that the existing routes were not balanced from the standpoint of either time or quantity of waste collected. The workers were required to complete an eight-hour day independent of actual time required for collection.

POLITICAL CONSTRAINTS

The political constraints existing in municipal government are more complex than typically found in private industry. These constraints affect not only costs but also restrain freedom of action in developing, implementing, and maintaining an incentive program. In some cities, the political environment may be so difficult that incentives are not feasible.

Political constraints may be categorized as follows:

Multiplicity of Interested Groups

Many groups have interests in and impact on the operation of a municipality. These groups include:

1) Citizens: individuals, organized special interest groups (e.g., Chamber of Commerce, neighborhood and civic organizations).

Figure 3. Covington Municipal Garage

Figure 4. Collection Truck Crew

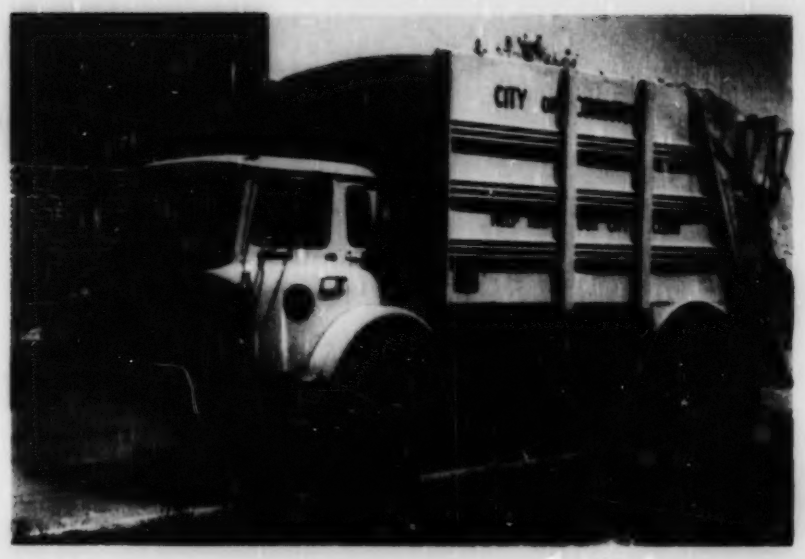

Figure 5. Rear Packer Truck, 18 Cubic-Yard

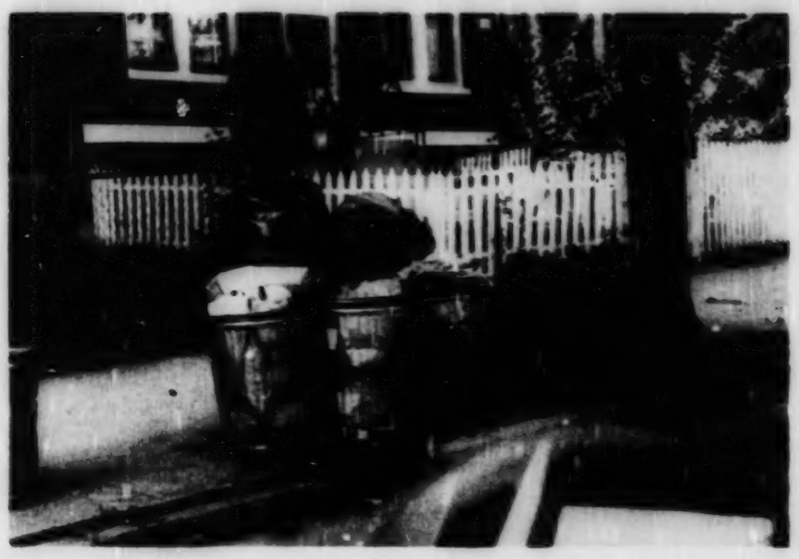

Figure 6. Curbside Setout

2) City management: mayor, commissioners, city manager, department heads, and subordinate administrative personnel.

3) Union/workers: individual employees, different bargaining groups, and workers excluded from incentive programs.

Characteristics of Management

In contrast to a private corporation, municipal management is often diffuse in its decision-making activities and transitory in leadership responsibility. There is no single overall authority in the typical city. Major decisions are usually influenced by at least several of the groups listed above. The city manager serves at the discretion of a majority of the commission. The commission members are elected by the citizens and are influenced by public opinion as expressed individually or through organized special interest groups. Frequently, the unions are politically active, and exert strong influence on public opinion and election outcomes. Meanwhile, city department heads, while organizationally reporting to the city manager, usually operate with a sense of independence and security provided through the civil service system.

Because of the nature of the appointment and elective process, city managers and commissioners generally experience a high rate of turnover, resulting in short-term accountability. Consequently, much time is expended in the "learning" process, with efficiency reduced, and long-range planning impaired.

Legislative Constraints

The successful planning implementation, and maintenance of a wage incentive program is also constrained by numerous legislative restrictions. Examples include:

1) Civil service regulations governing personnel policies, e.g., hiring and layoff, job bidding, and wage levels.

2) State laws restricting the right to strike or regulating bargaining, e.g., Ohio Ferguson Act and the New York Taylor Law.

3) Laws specifying length of work day or denying payment of incentive bonuses.

2 INCENTIVE SYSTEMS

INTRODUCTION

Among the major problems confronting an organization is the improvement of productivity through more efficient use of limited resources. While this problem is shared by both industrial and governmental organizations, it is particularly important to a municipality as it is pressed to maintain its service-oriented, labor-intensive functions in the face of inflation while on a relatively fixed income base.

One approach to the problem of increasing productivity is to motivate employees to increase their production either through increased effort and/or improved methods. A unit output of production may be a tangible physical product such as a solid state electronic circuit board, or a less tangible unit such as number of arrests, or building inspections.

One method for motivating employees is to compensate them for increased productive output. Any compensation offered for improved performance or behavior is, in a broad sense, an *incentive*.

Incentive plans can be divided into three broad categories: direct monetary, indirect monetary, and non-monetary.[1*] Under a direct monetary plan, each employee is compensated directly for his or her output or increased output. Direct plans can be either individual or group. Under the group plan, each member of the group is compensated an equal percent of bonus for the group's increased output.

Under indirect monetary plans, the employee's compensation is not a direct function of his individual or group output. Examples of indirect monetary plans include profit sharing, fringe benefits, and retirement benefits. Non-monetary plans do not involve any type of payment or other financial renumeration. Rather, they provide other benefits such as job enrichment, free time, or better working conditions to be discussed later in Section 3.

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* References and footnotes at end of Section.

Incentive plans are not new. The Chaldeans developed the principle of the incentive wage plan in 400 B.C.[2] Piece work payment, payment for each unit of output, has existed for centuries. The trade guilds of the Middle Ages set standards for quality and quantity. Modern wage incentive plans were devised in the late nineteenth and early twentieth centuries.

The use of time study techniques to set standards for wage incentives was introduced by Frederick W. Taylor. Taylor presented the results of his studies in 1895 and advocated high wages associated with high productive output. Methods work studies were pioneered by the Gilbreths in the 1910's.

REVIEW OF CLASSICAL DIRECT MONETARY INCENTIVE PLANS

In order to establish a proper perspective for a solid waste wage incentive program, the major incentive plans are briefly reviewed below.

Piecework

Straight piecework is the oldest and simplest form of incentive payment systems. Under piecework, the worker is paid a fixed monetary amount for each piece produced. There is no floor guaranteed wage. Direct labor costs are fixed at a constant level, at all levels of output. Straight piecework is no longer used in the United States due to federal minimum wage legislation.

Manchester Plan

The Manchester Plan combines a piece rate with a guaranteed minimum time wage. The Manchester is one of the most common forı of incentives in industry today due to its simplicity. The plan offers an incentive for management to keep production running smoothly due to the minimum wage floor.

Standard Hour Plan

The Standard Hour Plan or 100 percent Time Premium Plan is similar to the Manchester Plan. Both have a minimum wage guarantee and both pay a 100 percent premium over standard. The main difference in the plans is that under the Manchester Plan, the rate is price per piece; while under Standard Hour the rate is time per piece. The worker is paid for standard hours worked rather than actual hours worked. If the worker produces ten hours worth of output in an eight hour day, he is paid for ten hours. The Standard Hour Plan is used extensively throughout manufacturing industries.

Halsey Premium Plan

The Halsey Premium Plan was developed in 1890 before the publication of Taylor's time study techniques. Output standards were based on foreman's estimates or on averages of past performance. The time value of production in excess of standard was shared by management and the worker, usually at a fifty-fifty rate. Since standards were set by historical data rather that time study, they were rather loose and inconsistent. The fifty-fifty division of value added was incorporated to protect management from runaway rates.

Rowan Premium Plan

The Rowan Premium Plan is similar to the Halsey Plan in many respects. The main difference is that the Halsey Plan compensates the worker at a constant rate, while the Rowan Plan compensates at a decreasing rate. The employer was protected to a greater extent from loose standard rates. However, the decreasing rate scale is more complicated for the employees to understand.

Taylor Differential Piece Rate Plan

Taylor believed that lower unit production costs could be quickly achieved if high procedures were generously rewarded and low procedures were penalized. The work standards under the Taylor Plan were set by time and methods study.

Under the plan, two piece rates were assigned to each job. A higher rate, higher than the normal rate, lower than the normal piece rate, was paid to workers who did not achieve the standard. The differential occurred at one hundred percent of the standard rate. The Taylor Differential is not used in this form today as it penalizes the sub-standard worker. Variations of the plan do exist with a guaranteed earnings floor.

Gantt Task and Bonus Plan

The Gantt Plan is very similar to the Taylor Plan except that a basic day rate is guaranteed. Also, the Taylor Plan rate is expressed in standard time per piece.

Emerson Efficiency Bonus Plan

The Emerson Plan guarantees a fixed base rate and incorporates an empirically determined sliding scale of bonuses to sub-standard workers, beginning at two-thirds of standard efficiency. The standard is set high and the sixty-six percent efficiency standard was considered to be the normal rate, on the average.

Emerson Plan bonuses range from 0.25 percent at sixty-six percent of efficiency to twenty percent at rates above one hundred percent of efficiency. The Emerson Plan enables new employees or apprentices to earn an incentive from the beginning of their employment.

Bedaux Point System

The Bedaux System reduces all work to a standard time. Each operation is time studied and rated by points. Each point represents the normal amount of work of one operator in one minute of time. A minimum pay rate is guaranteed and the premium is divided between direct and indirect labor, usually at a ratio of seventy-five percent to the former, and twenty-five percent to the latter.

Most of the above plans are variations of the others. The main difference in the plans is how the rate is expressed, in price per piece or standard time per piece. Figure 7 is a graphical representation of the various plans and their compensation rates.[3]

Group Incentive Plans

The most common type of group incentive plan is profit sharing. Profit sharing is an indirect form of incentive, and therefore does not have the advantage of being transferred directly and immediately into the worker's paycheck. Non-profit organizations, of course, can not participate in this type of program.

Group incentive plans have many advantages over individual incentive plans: clerical and inspection systems are simplified, time study and cost systems are simplified, the spirit of teamwork increases mutual helpfulness, reduces labor turnover, and decreases idle time, and indirect workers can be included.[4]

On the other hand, the larger the group, the less the individual responds to the plan and a greater degree of group leadership and cooperation is required. Many of the group plans are indirect incentive plans, among these are the Kaiser Steel, Scanlon and Rucker plans.

Kaiser Steel Sharing Plan

The Kaiser Steel Plan[5] grew out of a strike settlement in 1959. The Plan guaranteed employment to employees displaced by technology or changes in work practices. The employment standard was based on the number of employees needed to produce a ton of steel in the base year 1961. Natural attrition of employees would reduce employment to actual production requirements.

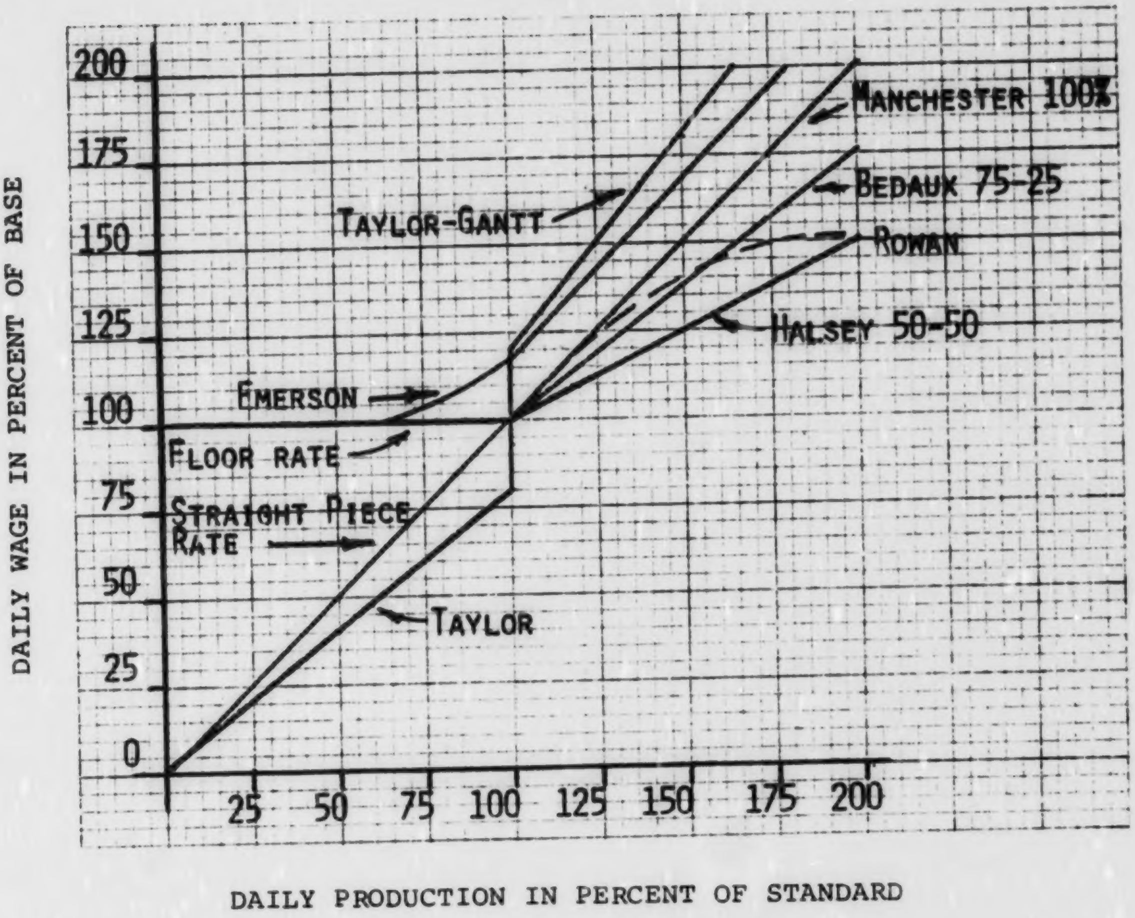


Figure 7. Earning Opportunities Under Wage Incentive Plans

The Plan incorporated a cost reduction incentive. Labor and operating costs per ton of steel were computed and used as a standard. Total savings in a subsequent period were reduced by capital investment and the balance was shared at the rate of 32.5 percent for employees and 67.5 percent for management.

The Plan was very successful in its early years. In the first year of Plan operation, bonus payments averaged about fifty cents an hour. In the third year, however, bonus payments averaged eighteen cents an hour and employee discontent with the system grew. Kaiser revised the bonus and liberalized the computation method in 1967.

Scanlon Plan

The Scanlon Plan[6] is similar to the Kaiser Plan and was also designed to reduce costs in a steel mill. The Plan is a value-added plan. The incentive formula is a percentage relationship between value added to raw materials (expressed by total sales values) and total payroll.

Several principles are explicit in the Plan:

1) Major participation is essential at all organizational levels.

2) Productivity or efficiency gains are to be paid on a regular basis, the amount to be determined by the success of the organization.

3) The Plan should be implemented within the context of the collective bargaining agreement, but maintained separately after installation.

The bonus was to be distributed seventy-five percent to all employees and twenty-five percent to the firm. Twenty-five percent of the bonus was held until the end of the year to cover any deficit period.

The base ratio, under the Plan, equals the sum of the factory payrolls, salaries, holiday, and vacation pay divided by net sales, plus or minus changes in inventory.

The Rucker Plan is similar to the Scanlon Plan. The main difference is in the analyses of the standards of efficiency. Both the Scanlon and the Rucker Plans established employee committees to make suggestions and to help in coordinating the plans.

Memorial Hospital MERIT Plan

The MERIT Plan[7], an acronism for Memorial Employees Retirement Incentive Trust, is an example of an indirect incentive plan for a non-profit organization.

The criterion used in the plan was savings in budgeted expenses. The savings were placed in an employee retirement trust fund.

A base period of 1958-1960 was established using an efficiency base of controllable expenses divided by total operating revenue. An efficiency improvement percentage is computed by subtracting the current years percentage from the base period. The hospital's contribution to individual earnings of employees is determined by the ratio of their earnings to total payroll.

Other Group Plans

The above group plans are all indirect in nature. The increase in productive output or in cost savings by an individual employee or group cannot be translated directly into increased earnings. The above plans do, however, include indirect as well direct workers in the plan.

Any of the individual direct incentive plans enumerated earlier can be extended to form a group plan. The group should be homogeneous and concerned with a single defined operation, e.g., solid waste collection. Each employee shares equally in the incentive bonus calculated on the output of the group. Piece-rate and Standard Hour plans are the most common direct group incentive plans.

USE OF DIRECT WAGE INCENTIVES IN INDUSTRY

A U.S. Government survey of 574 firms with wage incentives showed an average decrease in unit costs of twelve percent, an increase in takehome pay of seventeen percent and an increase in productivity of thirty-eight percent.[8]

The above results notwithstanding, an earlier Factory Magazine survey showed the application of both wage incentives and work measurement to be decreasing in manufacturing industries.[9] The magazine surveyed 751 manufacturing plants in twenty-one industries and compared the results with a similar survey conducted in 1959. In 1959, sixty percent of the plants used work measurement and fifty-one percent used wage incentive payment systems. In 1965, only forty-eight percent of the firms used work measurement and forty-one percent employed wage incentive systems. Small manufacturing plants (500 or fewer employees) moved away from both work measurement and wage incentives. Large plants continued steady in their use of incentives but increased work measurement applications. The survey further showed that union participation in the administration of incentives had fallen off. Of the plants using incentives, however, ninety-three percent reported a reduction in operating costs, seventy-seven percent reported an increase in morale and eighty-seven percent reported that incentives helped supervisors. Nearly twice as many plants reported quality increases as reported quality decreases.

While wage incentive use has been decreasing in manufacturing especially in the smaller plants, there has been an increase of incentive use in service related activities. The payoff of a properly administered wage incentive system is substantial. A trend currently exists toward group incentives and away from individual incentive plans as they are easier to administer and increase worker morale through teamwork.

SURVEY OF INCENTIVE PROGRAMS FOR PUBLIC EMPLOYEES

Although monetary incentives have been widely used in manufacturing industries for several decades, their application to the service-oriented sector of the economy (including most governmental activities) has been limited. Accompanying the recent shift in the United States economy from one of manufacturing to service has been a growing interest in the use of incentive programs for service-oriented public employees. The diversity of current incentives for government employees is illustrated in Figure 8 recently published by the National Commission on Productivity and Work Quality.[10] The broad categories are not necessarily distinct. For example, a wage incentive program for solid waste personnel could involve the concepts of piece-work (wages a direct function of work output), shared savings (cost savings shared by the public entity and the appropriate employees), task system or time incentive (employees free to leave work following completion of assigned collection route), productivity bargaining (sharing formulas subject to negotiation), and work standards for measuring work output.

The Commission reports that 1) the application of piece-work incentives in local government is very limited but expected to increase[11], 2) work standards are rarely used as a basis for monetary incentives[12], and 3) productivity bargaining is relatively new to public employees primarily because more explicit work standards are needed.[13]

A survey of monetary incentives currently in use or recently attempted by state and local governments for sanitation personnel is provided below. The listing excludes cash awards for outstanding service or suggestions.

Local Government Usage of Employee Incentives: A Summary of Survey Results from 509 Jurisdictions as of August–December 1973 [1]

Incentive	COLUMN 1 Cities 25–50,000		COLUMN 2 Cities Larger than 50,000		COLUMN 3 Counties Larger than 100,000		COLUMN 4 Total of all Cities and Counties (Col. 1 + Col. 2 + Col. 3)		COLUMN 5 Evaluation of the Incentive Programs	
	No. of Cities Reporting Use	% of 40 Respondents	No. of Cities Reporting Use	% of 315 Respondents	No. of Counties Reporting Use	% of 154 Respondents	No. of Cities/Counties Reporting Use	% of 509 Respondents	No. of Reported Evaluations	% of Total No. of Programs Reported (Col. 5 ÷ Col. 4
Educational Incentives	22	55	218	69	63	41	303	60	14	7
Output-Oriented Merit Increases	17	43	135	43	61	40	213	42	22	10
Task Systems	17	43	131	42	9	6	157	31	17	11
Suggestion Awards	6	15	93	30	29	19	128	25	8	6
Attendance Incentives	7	18	85	27	26	17	118	23	12	10
Variations in Working Hours	6	15	77	24	33	21	116	23	19	16
Safety incentives	4	10	73	23	14	9	91	18	5	6
Job Enlargement	2	5	54	17	17	11	73	14	4	6
Work Standards	2	5	37	12	27	18	66	13	0	0
Performance Targets	4	10	41	13	10	7	55	11	0	0
Performance Bonuses	0	0	27	9	5	3	32	6	4	13
Productivity Bargaining	2	5	20	6	5	3	27	5	2	7
Competition & Contests	1	3	14	4	0	0	15	3	1	7
Shared Savings	0	0	3	1	1	1	4	1	2	67
Piecework	0	0	3	1	0	0	3	1	1	33
Others [2]	0	0	23	7	7	5	30	6	0	0
None	7	18	30	10	47	31	84	17	—	—
Total Items Reported	90	—	1,034	—	307	—	1,431	—	111	8

[1] A total of 772 survey questionnaires were mailed: 52 to cities 25–50,000 in population, 408 to cities of more than 50,000, and 312 to counties of more than 100,000 population. 76.9 percent of these jurisdictions responded.

[2] This includes career development programs, nonmonetary rewards and recognition (e.g., service pins, banquets), deferred compensation, attendance at seminars, and negative incentives (e.g., denial of step increases).

Source: National Commission on Productivity and Work Quality, Employee Incentives To Improve State and Local Government Productivity, 1975, p. 7

Figure 8. Local Government Usage of Employee Incentives

Sacramento, California

Qualifying employees who accummulate six or more days of unused sick leave in a single year may choose to receive a partial cash payment.

St. Petersburg, Florida

The commercial collection crew with the highest weight per load average receives small monthly bonuses.

Kansas City, Missouri

All field employees in the solid waste division are divided into seven competitive teams of about 17 employees each. At the end of each 6-month period, each member of the team with the fewest total number of preventable vehicular accidents plus preventable personal injuries wins a $20 cash bonus.

Phoenix, Arizona

All nonsupervisory and first-level supervisory personnel of the sanitation department were divided into 29 groups. Every member of a group accident-free for 28 consecutive days received a $5 cash award. After a substantial decline in reported accidents the first year, the rate leveled off and subsequently began to rise. After discontinuance of the incentive in December 1973, accident rates climbed to their preincentive level. Current management does not favor paying employees for good safety practices.

Washington, D.C.

In 1971 contract negotiations, sanitation workers agreed to an increase in the standard day's work in exchange for a 2 percent pay increase. In addition, the contract provides for increased participation by sanitation employees through a Productivity Committee comprised of labor and management representatives. The Committee meets monthly to resolve labor-management conflicts and receive employee complaints.

Council Bluffs, Iowa

During 1974 negotiations with a local bargaining unit organized within the public works department, City management required that all future salary and benefit increases would be contingent on maintenance of current productivity standards. Specification of productivity work standards is planned following legalization of collective bargaining (July 1975).

Lake Charles, Louisiana

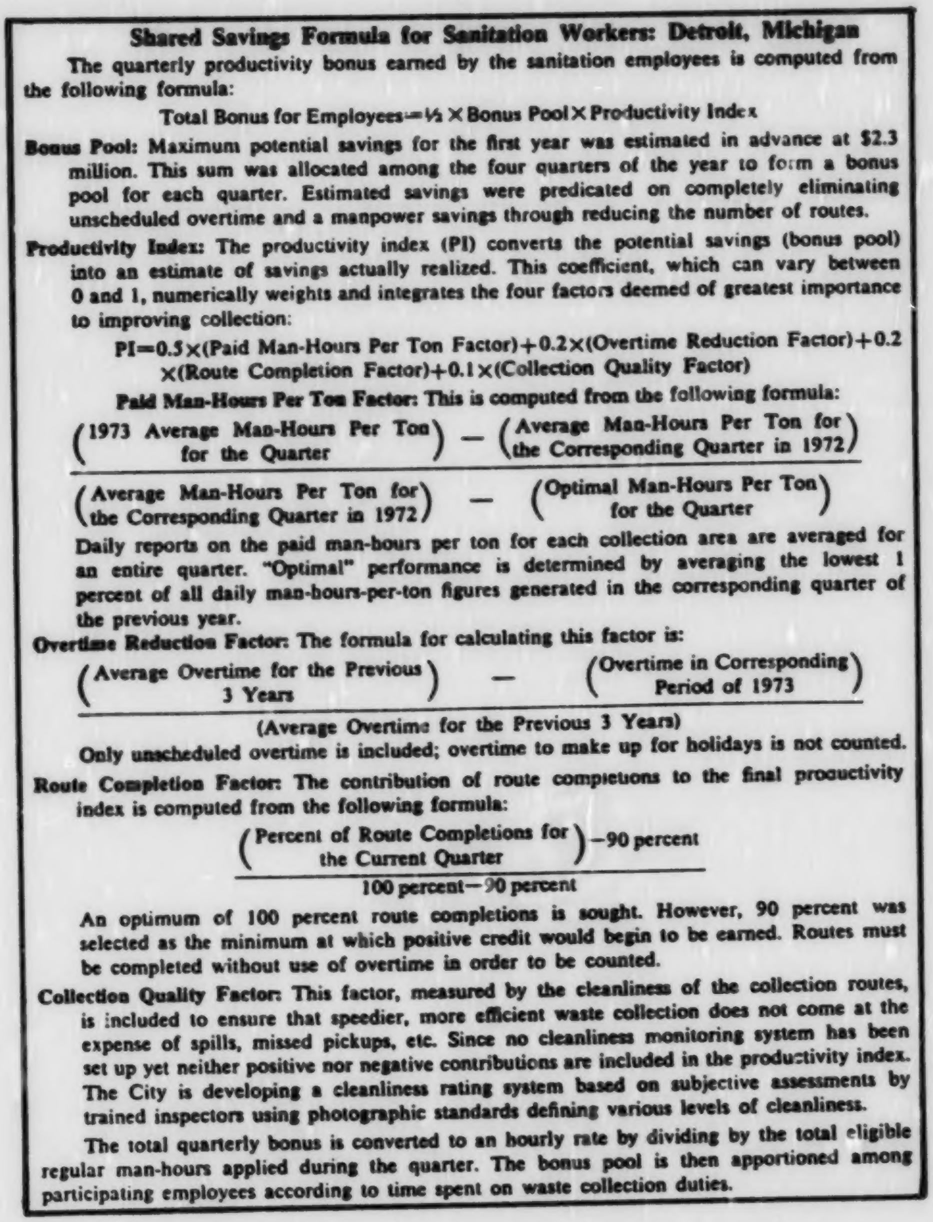
In 1973, as part of a new union contract, the City agreed to share with its sanitation employees any savings in workman's compensation insurance refunds resulting from reduced accident rates. The savings realized are being shared with the employees in the form of a permanent 5.5 percent annual merit increase effective May 1974.

Detroit, Michigan

As a result of negotiations precipitated by the introduction of larger packer trucks, the City of Detroit and its sanitation workers agreed in July 1973 to share resulting savings "50-50" between the City and the workers. Nearly everyone in the sanitation department directly involved in solid waste collection (over 1,000 individuals) are included in a single bonus group. The bonuses are apportioned among the group members according to time spent on waste collection activities. The total amount of the cash bonus to be distributed each quarter is calculated from a rather complex formula (Figure 9) which weights four performance factors: man-hours per ton, overtime reduction, route completion, and cleanliness. Early bonuses averaged 5 and 6 percent of salaries, declining somewhat in more recent quarters. City officials have reported that individual incentive is reduced somewhat by the largeness of the bonus group.

Flint, Michigan

In September 1973, the City and the local union ratified a contract which introduced both a time incentive or task system and an annual monetary bonus for cost savings. According to Flint officials, a prerequisite of both the task system and shared-savings plan is that collection routes be closely balanced among all crews and designed to represent a fair day's work. Between August 1973 and January 1974 Flint's routes were equalized using heuristic routing techniques. The new task system permits a crew to go home after six hours if its route is completed. If assigned to assist another crew, overtime is earned past the six hours. All members of the waste collection division including supervision (about 65 individuals) are members of the monetary incentive group, and share equally in any earned annual bonus. The bonus is based on a formula involving overtime savings, quality, and reduced costs per ton (Figure 10). In renewing the contract agreement, provision was added for reducing the bonus on an individual basis for unexcused absences, and the addition of $2000 to the bonus pool for each employee reduction below a base level. The program has been generally successful, but some problems arose with respect to employees excluded from the incentive. City and union officials recommend that jurisdictions comtemplating such an incentive program should 1) gather the necessary baseline data before designing the program, 2) involve the employees in plan formulation, and 3) keep it simple.



Shared Savings Formula for Sanitation Workers: Detroit, Michigan

The quarterly productivity bonus earned by the sanitation employees is computed from the following formula:

$$\text{Total Bonus for Employees} = \tfrac{1}{2} \times \text{Bonus Pool} \times \text{Productivity Index}$$

Bonus Pool: Maximum potential savings for the first year was estimated in advance at $2.3 million. This sum was allocated among the four quarters of the year to form a bonus pool for each quarter. Estimated savings were predicated on completely eliminating unscheduled overtime and a manpower savings through reducing the number of routes.

Productivity Index: The productivity index (PI) converts the potential savings (bonus pool) into an estimate of savings actually realized. This coefficient, which can vary between 0 and 1, numerically weights and integrates the four factors deemed of greatest importance to improving collection:

$$\text{PI} = 0.5 \times (\text{Paid Man-Hours Per Ton Factor}) + 0.2 \times (\text{Overtime Reduction Factor}) + 0.2 \times (\text{Route Completion Factor}) + 0.1 \times (\text{Collection Quality Factor})$$

Paid Man-Hours Per Ton Factor: This is computed from the following formula:

$$\frac{\left(\begin{array}{c}\text{1973 Average Man-Hours Per Ton}\\ \text{for the Quarter}\end{array}\right) - \left(\begin{array}{c}\text{Average Man-Hours Per Ton for}\\ \text{the Corresponding Quarter in 1972}\end{array}\right)}{\left(\begin{array}{c}\text{Average Man-Hours Per Ton for}\\ \text{the Corresponding Quarter in 1972}\end{array}\right) - \left(\begin{array}{c}\text{Optimal Man-Hours Per Ton}\\ \text{for the Quarter}\end{array}\right)}$$

Daily reports on the paid man-hours per ton for each collection area are averaged for an entire quarter. "Optimal" performance is determined by averaging the lowest 1 percent of all daily man-hours-per-ton figures generated in the corresponding quarter of the previous year.

Overtime Reduction Factor: The formula for calculating this factor is:

$$\frac{\left(\begin{array}{c}\text{Average Overtime for the Previous}\\ \text{3 Years}\end{array}\right) - \left(\begin{array}{c}\text{Overtime in Corresponding}\\ \text{Period of 1973}\end{array}\right)}{(\text{Average Overtime for the Previous 3 Years})}$$

Only unscheduled overtime is included; overtime to make up for holidays is not counted.

Route Completion Factor: The contribution of route completions to the final productivity index is computed from the following formula:

$$\frac{\left(\begin{array}{c}\text{Percent of Route Completions for}\\ \text{the Current Quarter}\end{array}\right) - 90\text{ percent}}{100\text{ percent} - 90\text{ percent}}$$

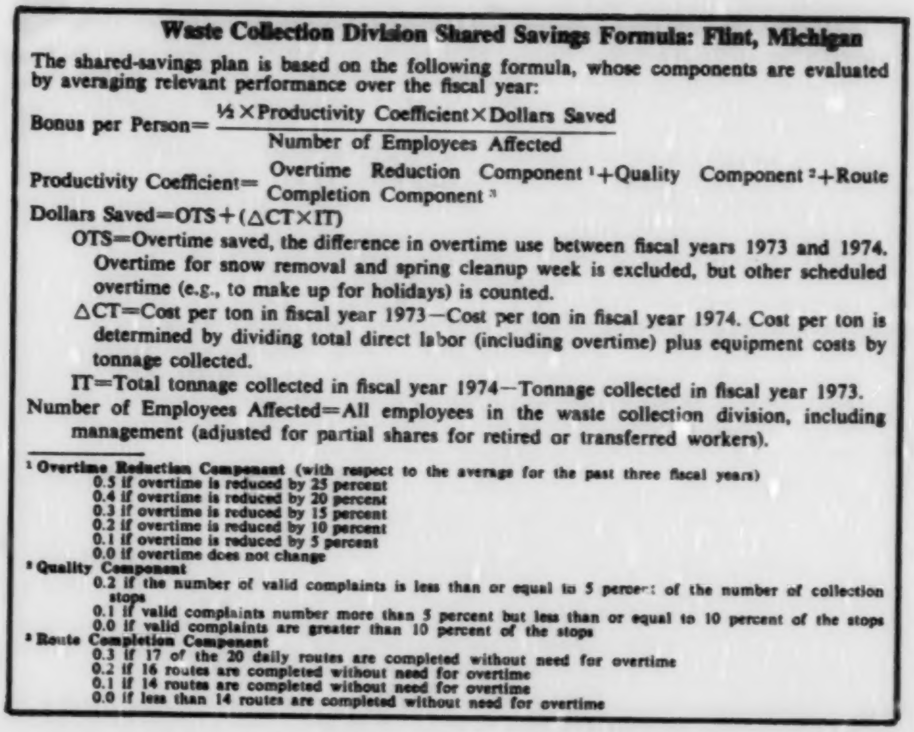
An optimum of 100 percent route completions is sought. However, 90 percent was selected as the minimum at which positive credit would begin to be earned. Routes must be completed without use of overtime in order to be counted.

Collection Quality Factor: This factor, measured by the cleanliness of the collection routes, is included to ensure that speedier, more efficient waste collection does not come at the expense of spills, missed pickups, etc. Since no cleanliness monitoring system has been set up yet neither positive nor negative contributions are included in the productivity index. The City is developing a cleanliness rating system based on subjective assessments by trained inspectors using photographic standards defining various levels of cleanliness.

The total quarterly bonus is converted to an hourly rate by dividing by the total eligible regular man-hours applied during the quarter. The bonus pool is then apportioned among participating employees according to time spent on waste collection duties.

Source: National Commission on Productivity and Work Quality, Employee Incentives To Improve State and Local Government Productivity, 1975, pp.83,84.

Figure 9. Detroit, Michigan Savings Formula



Waste Collection Division Shared Savings Formula: Flint, Michigan

The shared-savings plan is based on the following formula, whose components are evaluated by averaging relevant performance over the fiscal year:

$$\text{Bonus per Person} = \frac{\tfrac{1}{2} \times \text{Productivity Coefficient} \times \text{Dollars Saved}}{\text{Number of Employees Affected}}$$

Productivity Coefficient= Overtime Reduction Component[1]+Quality Component[2]+Route Completion Component[3]

Dollars Saved=OTS+(ΔCT×IT)

OTS=Overtime saved, the difference in overtime use between fiscal years 1973 and 1974. Overtime for snow removal and spring cleanup week is excluded, but other scheduled overtime (e.g., to make up for holidays) is counted.

ΔCT=Cost per ton in fiscal year 1973—Cost per ton in fiscal year 1974. Cost per ton is determined by dividing total direct labor (including overtime) plus equipment costs by tonnage collected.

IT=Total tonnage collected in fiscal year 1974—Tonnage collected in fiscal year 1973.

Number of Employees Affected=All employees in the waste collection division, including management (adjusted for partial shares for retired or transferred workers).

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[1] **Overtime Reduction Component** (with respect to the average for the past three fiscal years)
0.5 if overtime is reduced by 25 percent
0.4 if overtime is reduced by 20 percent
0.3 if overtime is reduced by 15 percent
0.2 if overtime is reduced by 10 percent
0.1 if overtime is reduced by 5 percent
0.0 if overtime does not change

[2] **Quality Component**
0.2 if the number of valid complaints is less than or equal to 5 percent of the number of collection stops
0.1 if valid complaints number more than 5 percent but less than or equal to 10 percent of the stops
0.0 if valid complaints are greater than 10 percent of the stops

[3] **Route Completion Component**
0.3 if 17 of the 20 daily routes are completed without need for overtime
0.2 if 16 routes are completed without need for overtime
0.1 if 14 routes are completed without need for overtime
0.0 if less than 14 routes are completed without need for overtime

Source: National Commission on Productivity and Work Quality, Employee Incentives To Improve State and Local Government Productivity, 1975, p. 93.

Figure 10. Flint, Michigan Savings Formula

A PROTOTYPE WAGE INCENTIVE PROGRAM FOR SOLID WASTE PERSONNEL

Objectives

The major requirements of a wage incentive program are twofold:

1) Political: All involved parties - elected officials, citizens, public works management, and workers/union - must be agreeable to the concept of time and direct monetary incentives. On an on-going basis, the city must continue to support the program fairly, e.g. defend the program to the citizens and to municipal employees not included in the incentive plan, maintain competitive base earnings, and share cost savings equally.

2) Technical: All collection route areas must contain accurately calculated work content. An example of collection route design is included in Section 7.

In addition, a wage incentive program must satisfy the requirements of three major groups: citizens, management, and the workers/union. These group requirements are:

Citizens:

1) Pickup must occur on the scheduled day.
2) Frequency of collection must be acceptable.
3) Collection must be completed with minimum littering.
4) Respect must be given to property and privacy, e.g., can damage, noise.

Management:

1) Total operating cost must not exceed budget.
2) Level and quality of service should be maintained or improved.
3) Productivity should be increased. If accomplished through incentives, the program should be acceptable to most employees.

Worker/Union:

1) Job security must be guaranteed.

2) Wage levels must be competitive with comparable jobs in the geographic area, and increase with the cost of living.

3) Required work levels must be physiologically reasonable, and work assignments throughout the group must be balanced and equitable.

System Constraints

The following constraints are inherent in solid waste collection/disposal operations:

1) The daily work assignment is fixed. That is, the waste should be collected on the scheduled days as announced to the citizen. This is particularly true for curbside pickup because of citizen set-out and the associated litter problems. In addition, the citizen's collection schedule is relatively inflexible.

2) The daily work content is variable. While the work assignment is relatively well defined and unchanging, the work content required for completing the assignment varies monthly, weekly, and even daily due to a multitude of factors such as the weather, traffic, equipment breakdown, accidents and illnesses, disposal delays, and changing waste generation patterns.

3) The work is accomplished by crews, each consisting typically of a driver and one or two laborers with a loadpacker truck. With multi-member crews, the collection method is both variable and complex, generally involving simultaneous activities.

4) Holiday schedules should be planned to provide collection service for all citizens.

5) The pay and skill levels of the collection personnel are usually low.

6) The work assignments of certain direct and indirect labor other than the collection crews are closely related to direct collection labor, for example, the collection foremen and the landfill equipment operators.

7) Activities of workers and/or management may be restricted by state and/or local laws and regulations.

If each collection area is to be picked up consistently on its scheduled day, provision must be made for handling the fluctuations that occur in the work content of a collection area from day to day. Management has only two alternatives for dealing with these variations on a day to day basis: either to make changes in the manpower and/or equipment assigned to the task (and these changes must of course be discrete rather than continuous), or to allow the time required for the task to vary either into overtime or into "undertime" (in which case the men may be idle a portion of the day). Generally, municipalities tend to avoid consistent overtime, choosing instead to permit the crews to complete their assignments early. If the men are allowed to leave work on completion of the assignment and are paid for a complete day, the program provides a time incentive ("task system"). Although time incentive programs are frequently used and offer certain advantages to both management and workers, they do require balanced work assignments if the system is cost effective and fair to individual employees. On a day-to-day basis, balanced work assignments are difficult to maintain between individual crews due to uncontrollable factors, especially sudden equipment failure. On a year-to-year basis, variations in waste generation patterns tend to develop in individual crew collection areas thereby requiring updating of the route assignments. An approach used by some larger municipalities to reduce the inequities between individual crews is to group several crews together into a team under the field supervision of a foreman. The team approach not only provides a mechanism for dealing with daily fluctuations in the work loads of its member crews but also tends to average out inevitable changes in waste generation patterns occurring in a dynamic city, thereby requiring somewhat less frequent route revision.

General Guidelines

Wage incentive programs for solid waste operations should be tailored for local conditions by municipal management. However, certain general guidelines are applicable to all locations. These guidelines include the following:

1. Management and workers must clearly understand all essential aspects of the program. To facilitate this understanding, the program must be straight-forward and simple.

2. A wage incentive program should also provide time incentives.

3. Workers/union should have meaningful involvement in the design and implementation of the program.

4. The program should permit the workers to elect the level of incentive earnings through selection of work content assignments.

5) The incentive group size should be as small as managerially feasible, consistent with system constraints.

6) Time and direct monetary incentives must be based on accurate work content determined by work measurement techniques.

7) The employees should be guaranteed job security.

8) The connection between incentive pay and actual performance should be direct and clearly understood by the workers. Incentive earnings should be paid timely.

9) Guarantees of necessary supportive services, e.g., backup men and equipment, supervisory assistance, and field communication equipment, must be included in the program.

10) The program should encourage regular worker attendance, minimum overtime, and acceptable quality of service.

11) Base wage levels for workers and supervision must be competitive with comparable jobs in the geographic area, and reflect appropriate cost-of-living increases.

12) Savings should be shared equally between the city and employees because this arrangement would most likely satisfy all interested groups.

13) The program should encourage implementation of improved methods or equipment.

14) The program should not preclude productivity bargaining between workers/union and management.

15) Attention should be given to properly informing the public of the benefits of an incentive program.

16) The program should provide for periodic review of work methods and standards, and incentive earnings.

Recommended Program: Elective Incentive Contract

If these two major requirements for program design are fulfilled and the guidelines followed, then a wage incentive program may be developed that allows for elective participation by individual work groups. The project results in the test City strongly indicate that such a program not only would be cost effective, but also offer high probability of long term success.

A program with elective participation may be defined as an Elective Incentive Contract (EIC) program. Fundamental to the EIC program are the following:

1) Collection is accomplished through incentive groups or teams consisting of approximately three to nine trucks and their assigned crews under the supervision of a field foreman.

2) All supportive personnel, e.g., superintendent, maintenance, and disposal, receive an incentive bonus based on the average of all teams.

3) Each team is assigned a collection route area requiring an average 6.5-hour standard work day, thereby providing a 1.5 hour daily time incentive. Team members are paid for eight hours and are permitted to leave after their respective team area has been collected.

4) In addition to the 6.5-hour standard work day, individual teams may elect to contract additional work content in return for a wage incentive bonus.

To illustrate the EIC program, consider a small solid waste collection/disposal system requiring two collection teams. Both teams initially consist of five rearloading packers and drivers, five laborers, and a field foreman. Team 1 contracts the standard 6.5-hour work day and receives base salaries without a wage incentive bonus. Team 2 contracts for a 7.5-hour work day and receives base salaries plus a wage incentive calculated by the simple equation below:

$$\begin{array}{c}\text{Wage Incentive}\\ \text{(percent)}\end{array} = \frac{(\text{Contract Day - Standard Day})\ 100}{8\ \text{hours}}$$

For a 7.5-hour contract day, the computation is:

$$\begin{array}{c}\text{Wage Incentive}\\ \text{(percent)}\end{array} = \frac{(7.5-6.5)\ \ 100}{8.0} = 12.5\%$$

Assuming a 30 percent overhead (including fringe benefits), the manpower reduction savings resulting from the 7.5 hour contract work day are:

Manpower Reduction Savings = (\$200/week) (1.54) (1.30) = \$400/week

Labor savings to the city is equal to the manpower reduction savings less bonus payments to team workers, foreman, and supportive personnel. Bonus payments to the workers would amount to \$250 (10 workers @ \$25 each). Assuming that bonus payments to the foreman and support personnel amount to \$50, the net labor savings to the city would be:

$$\text{Net Labor Savings To City} = \$400 - \$250 - \$50 = \$100/\text{week}$$

In addition to these savings, the city would realize equipment savings associated with the reduction in manpower. For each crew reduced (2 workers), there is a reduction of one truck. Assuming a weekly truck cost of \$200, the equipment savings would be:

$$\text{Equipment Savings} = \frac{1.54}{2} (\$200/\text{week}) = \$154/\text{week}$$

In this example, total weekly savings to the city equals \$254, while the total weekly bonus payments to workers (including foreman and support personnel) equal \$300. Obviously, truck and manpower reductions can only occur in integer units.

A second example illustrates how the program would respond to introduction of equipment improvements resulting in cost savings with no change in work content. Assume that the ten rearloaders with two-man crews are replaced by fourteen sideloaders with one-man crews. This represents a reduction of six men. The resulting weekly labor savings including fringe benefits would be:

$$\text{Labor Savings} = (\$200)\ (6)\ (1.3) = \$1560/\text{week}$$

Assuming the weekly incremental equipment cost for four trucks amounts to \$800, then the net weekly savings is \$760. It is recommended that the city and the workers share in the savings from equipment improvements the first year. Following this time, the city would retain any on-going savings. On this basis, a \$380 equipment implementation weekly bonus would be distributed among the participating employees. This would amount to over \$20 weekly for each employee, or an annual total individual implementation bonus of over \$1000. Since this is a one-time bonus, it should not be included in the weekly pay check, but preferably distributed in two payments, e.g., 20 percent paid soon after implementation of the new equipment and the remaining 80 percent at the end of one year.

Since under the EIC program, the work groups contract to complete their elected collection assignment, overtime pay is avoided except for scheduled holidays. Care must be exercised during implementation of collection improvements to avoid employee layoffs if possible. Consequently, actual savings may lag implementation until manpower levels are adjusted through attrition or reassignment.

A Comparison of the Elective Incentive Contracts with Existing Programs in Detroit and Flint, Michigan

Within the last two years, wage incentive plans have been implemented in Detroit and Flint, Michigan, as described earlier. These two plans and the proposed EIC have the following similarities:

1) No employee shall be laid off as a result of the incentive program.

2) Savings shall be shared between employees and the city.

3) Most waste collection employees including supervision participate in the incentive.

4) All plans utilize task (time incentive) or modified task systems.

The Detroit plan differs from the EIC in the following features:

1) The principal measure of productivity in the Detroit plan is man-hours per ton.

2) A standard day's work is defined as the completion of a single 25-yard packer route.

3) Bonus is calculated with a rather complex formula.

4) Some employees still receive overtime pay at the expense of group bonus.

The differences of the Flint plan include the following:

1) The principal measure of productivity in the Flint plan is cost per ton.

2) The bonus formula is fairly complicated.

3) Some employees still earn overtime, reducing group bonus.

4) Landfill personnel elected to receive 10¢ per hour base pay increase in lieu of participating in the incentive.

5) For each worker eliminated, $2000 is added to the bonus pool for sharing.

6) Individuals are penalized for absenteeism with reduction of incentive earnings.

7) On renegotiation of the incentive agreement, the workers/union were guaranteed a minimum incentive bonus of $.10 per hour.

Three major differences between the EIC and the Detroit and Flint plans are:

1) In the EIC, work content is determined from detailed field data and application of work measurement techniques. Detroit and Flint both base their incentives on a prior "base" year.

2) The EIC program has a relatively small incentive group consisting of a small number of truck-crews and a foreman. Both Detroit and Flint include the entire work force in a single group.

3) In the EIC, bonuses are paid weekly. Detroit presently pays quarterly and Flint annually.

EVALUATING AN INCENTIVE PROGRAM

The purpose of an incentive program is to increase productivity through the more efficient use of available resources. Increased productivity can effect two major changes in a solid waste system. First, improvements can be realized in citizen service, e.g., increased collection frequency, reduction of litter, and reduction of incompleted routes. Second, acceptable service is maintained while lowering annual costs. Consequently, an incentive program should be evaluated on the basis of its resulting savings and citizen services provided.

In evaluating savings, the following should be included:

1) The savings resulting from the initial program implementation. These savings are relatively easy to measure as they occur during a short time period.

2) The on-going annual equipment and personnel savings resulting from the incentive program. These savings should be determined by evaluating the current operating year costs with and without incentives, as opposed to comparing with a prior base year.

In program evaluation, services must be compared consistently. For example, if littering increases because of hurried collection to earn an incentive bonus, then real productivity may not be improved.

Finally, the program must have good prospects for longevity. It must continue to be economically and politically acceptable to all concerned parties.

FOOTNOTES

[1] Niebel, B. W., Motion and Time Study, Irwin, Homewood, 1972, p. 605.

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[3] Baumback, C. M., Structural Wage Issues in Collective Bargaining, Heath, Lexington, 1971, p. 146.

[4] Marriott, p. 66.

[5] Dunn, J. D., & Rachel, F. M., Wage and Salary Administration: Total Compensation Systems, McGraw-Hill, New York, 1971, p. 251.

[6] Ross, T. L., & Jones, G. M., "An Approach to Increased Productivity: The Scanlon Plan", Financial Executive, Vol. 40, No. 23, Feb. 9, 1972, p. 23-29.

[7] Dunn & Rachel, p. 256-258.

[8] "Innovation is Changing Old Ideas on Incentives", Industry Week, Vol. 167, No. 24, July 27, 1970, p. 24-33.

[9] Schultz, G. V., "Plants' Incentives Slump Badly over Last 6 Years", Factory, Vol. 123, No. 6, June, 1965, p. 68-79.

[10] National Commission on Productivity and Work Quality, Employee Incentives to Improve State and Local Government Productivity, March, 1975, p. 7.

[11] National Commission on Productivity and Work Quality, p. 73.

[12] National Commission on Productivity and Work Quality, p. 112.

[13] National Commission on Productivity and Work Quality, p. 79.

3 MOTIVATION AND JOB PERFORMANCE

INTRODUCTION

Job performance and specifically individual differences in job performance have long occupied the attention of social science researchers, industrial engineers, and managers. Early research effort was directed mainly toward minimizing or eliminating differences in job performance through training and job design. The investigations by Frederick W. Taylor, Frank B. Gilbreth, and others were designed to serve the interests of effective factory management. Their central aim was to reduce human variability, to make the work process as machine-like as possible using time-and-motion studies and specialization (the division of labor). Workers were relegated to the status of physical resources necessary for production. Little effort was made to understand why individuals differed in their productivity on similar jobs.

The view of the worker as merely a physical resource was abruptly and radically challenged by the findings of the Hawthorne studies (Roethlisberger and Kickson, 1939). This was a major research effort designed to identify the relevance of situational factors to employee productivity. Since that time, the study of work behavior has shifted toward an emphasis on what could be called the "human" side of work. Today, management is largely concerned with the most efficient deployment and organization of man and machine. There is almost as much interest in adapting the machine to particular characteristics of the human operator as in adapting the human being to the machine.[1*]

Voluminous research literature exists on the technical conditions of work. Both organized labor and industry, as well as government, spend millions annually in seeking out the most efficient and beneficial uses of human labor resources. Much of what is known about human work has become available only during the last two or three decades, as a result of this shift in emphasis.[2] Today, no one would argue against the idea that such factors as worker ability, motivation, training, organizational structure, organizational climate, and various human relations policies all have some direct or indirect relationships on how the employee behaves on the job. Many social scientists have constructed theories regarding the relationship between job attitudes, job satisfaction, motivation, and ultimate job performance.

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*References and footnotes at end of Section.

The ultimate goal in developing a theory of work motivation is to help understand and predict the conditions under which a person will be motivated to work and those under which a person will not. The motivational framework for job performance will aid in understanding the conditions under which people will be willing to engage in creative, change-oriented behavior and under which they will accept the introduction of change and innovation necessary in a dynamic world. While this type of behavior is dependent upon other variables in addition to motivation, motivation is crucial as one of the mechanisms by which one can interpret and predict these types of behavior.

The results of behavioral research studies and subsequent theories as to the attitude-motivation-productivity complex already fill volumes. While there are many cases on record where the traditional system of rewards and punishments has worked quite well to improve output performance, there are many where it has not, and it is partially because of these puzzling inconsistencies in work behavior that interest in this area has been so great.

MOTIVATION AND PERFORMANCE OVERVIEW

In recent years, efforts have been directed toward linking human motivation with performance and productivity levels. Much of the emphasis has been on the psychological and sociological aspects of work. This orientation is rooted principally in the common interests of managers and behavioral scientists in gaining greater productivity, not so much by improving the technology as by improving the motivational climate. New ways are being sought to meet the technological demands, and at the same time to provide the opportunity for the employee to satisfy his fundamental need for involvement in work that has personal relevance and meaning.[3, 4]

Some of the principal concepts that have emerged from current behavioral science research are concerned with the division of labor and the relation between the work a person does and his mental health and motivation. A Conference Board study[5] found widespread interest in the application of behavioral science technology to the work situation. What was found was that several firms were trying to improve the quality and challenge of work in order to increase employee motivation. This movement is diverse, and the theories of how to mesh organizational requirements with individual goals differ, but the common approach has been centered on manipulation of the job content instead of manipulation of the employee to fit the job. The current focus is on job design for motivation.

The design or redesign of jobs has a single purpose: to increase both employee motivation and productivity. Several approaches have been and are being used with varying degrees of success concerning job redesign. These include primarily: job rotation, job enlargement, job enrichment, and work simplification, with these techniques being used separately or in combination.

Job rotation often implies rotating an employee through a series of departments or jobs for short periods of time for the purpose of orientation. It can be used as a training or development tool in moving an employee through a series of operations to broaden his knowledge and perspective of the total operation. In job design, the rotation usually is within a prescribed series of tasks; the jobs themselves are not redesigned or modified, and the worker's responsibility is for the specialized part of the operation that he performs at any given time.

Job enlargement denotes the addition of one or more related tasks to the basic job. The employee learns to perform several steps in the operation required to make a product or perform a service. The responsibility is enlarged from one specialized job to include other related sequences.

Much of the early work in job design for motivation took the form of job enlargement. Proponents of job enlargement cite reduced fatigue, relief from boredom of highly specialized work, and broadened work skills as motivational factors. The underlying assumption is that the bigger the job, the more intrinsically satisfying it is. There has also been some criticism that job enlargement has little possitive impact on employee satisfaction.

Another form of job design is work simplification. Although this technique may sound somewhat contradictory in that it takes on the connotation of work specialization or the further division of labor espoused by Taylor et. al., it is different in that its aim is to break the work processed down into their smallest segments in the hope that unnecessary steps can be eliminated, or combining steps where possible. It is often used as a part of job enrichment efforts since employees can participate in analyzing jobs and redesigning them for greater efficiency. In doing so, the worker becomes intimately involved in the planning and design of the work under his control. Several small research projects have been documented in the professional journals. Many of these projects were conducted under actual working conditions in functioning organizations; but, only a few job design projects for larger organizations have been reported. Some of these are regarded as "classics," notably those projects or experiments within General Electric,[7] IBM,[8] Imperial Chemical Industries,[9] and American Telephone and Telegraph Company[10].

The Conference Board study (Rush, 1971) examined job design projects on six other large companies, although these projects for the most part could be called "pilot" projects. The six companies investigated in this report were: Arapahoe Chemicals, Texas Instruments Inc., U.S. Internal Revenue Service, Weyerhauser Co., Valley National Bank, PPG Industries, and the Monsanto Company.

The results of studies on these job design projects indicate that transforming the various job design techniques or theories into the actual working situation is difficult at best. The Conference Board study makes it apparent that one job design technique is rarely used alone. For example, the Weyerhauser effort relied strongly on work simplification, but an equal emphasis was put on interpersonal competence and teamwork. The PPG Industries case illustrates the enlargement for production and maintenance workers. In the Monsanto study, the section on chemical operators in a nylon plant is an example of job rotation combined with job enrichment.

The ultimate in job design application would be what Rush refers to as an "autonomous or semi-autonomous work group"---an idealized organizational construct that some job design advocates dream about, but that rarely exists in its "pure" form in practice[11]. The work group is organized into a work unit with a common product or service function. Within the framework of the larger organization's long and short range objectives, the group as a whole is accountable for predetermined quantity and quality of output. But beyond this accountability, the organization permits the group to operate independently. The manner in which they plan, organize, perform, and control their work is left up to the group, as is the behavior and performance of the group's members. The group is accountable to management and the individual members are accountable to the group.

The lack of most companies to employ job design techniques on a broad scale indicates that barriers to job design exist. Little and Warr classify these barriers as job factors and organizational factors[12], while Rush declares these barriers to be organizational and attitudinal[13]. As discussed in Section 1, political barriers also exist in a governmental framework.

In addition to job design techniques, several other methods have been proposed to stimulate the motivational climate of the work situation. These include incentive plans as previously discussed in Section 2 and modification of the work week. In industry, some companies have switched to the four-day week instead of the traditional 8-hours, five-days-a-week system. As discussed later in Section 7, one waste collection alternative involves the use of a four-day work week. For those collection systems that are politically constrained to a twice-a-week pickup, the four-day-work-week alternative is superior to the others in terms of simplification of design. This alternative permits a minimum of three days between collections, and simplifies holiday work week schedules.

JOB SATISFACTION

Worker job satisfaction has gradually emerged as a prime focus of modern organization development. In the past, job satisfaction was studied mainly as an isolated variable for its possible predictive usefulness in understanding worker job performance. However, recent research has viewed job satisfaction as a dependent variable, worthy of independent study, and also investigated to determine its relationship to other factors that may affect worker behavior.

The question of how job satisfaction influences job performance is not clearly answered. In an early paper published by Crockett and Brayfield (1955), it was suggested that an explicit theoretical linkage existed between satisfaction, motivation, and the organization's goal of productivity. The authors conclude:

> It makes sense to us to assume that individuals are motivated to achieve certain environmental goals and that the achievement of these goals result in satisfaction. Productivity is seldom a goal in itself, but more commonly a means to goal attainment. Therefore, we might expect high satisfaction and high productivity to occur together when productivity is perceived as a path to certain important goals and when these goals are achieved[14].

Hence, it was not determined that a relationship existed between productivity and worker morale.

Frederick Herzberg and his associates[15, 16] used a semi-structured interview technique to get respondents to recall events experienced at work which resulted in a marked improvement or a marked reduction in their job satisfaction. Content analysis of the interviews suggested that certain job characteristics led to job satisfaction, while other job characteristics led to job dissatisfaction. For example, job achievement was related to satisfaction while working conditions were related to dissatisfaction. The researchers concluded that satisfaction and dissatisfaction are not simple opposites, therefore, a two-factor theory of satisfaction is required.

Although Herzberg and others[17], continue to develop research methodologies to test the two-factor theory, conflict surrounding the soundness of the theory has delayed its general confirmation[18, 19].

Job satisfaction has been defined by J. C. Wofford as the overall attitude of well-being with regard to the job and its environment, with satisfaction being a function of the difference between an individual's strength of needs and the fulfillment of those needs on the job. To distinguish job satisfaction from job motivation, Wofford defines the latter as the tendency to perform or to expend effort required to maintain a high quantity and/or quality of output. He described motivation as a multiplicative function of the individuals' strength of needs and the expectancy that performance will result in need gratification. Thus, motivation is the variable which leads to relevant rewards via performance and effort, while satisfaction is determined by the difference between the expectancy of rewards and the actual attainment of those rewards. The motivation-performance interaction is antecedent to satisfaction. Although job satisfaction can influence an individual's evaluation of the strength of needs and the expectancy function of his next behavioral decision. In this frame, the motivation, performance and satisfaction model is somewhat sequential. It is, at this point, not clear that satisfaction alone influences the degree of motivation toward relevant goals. For example, a person may be highly motivated to perform in such a way as to lead to perceived rewards despite previous disappointments. However, researchers generally agree that motivation and performance are antecedent to satisfaction.

In summary, this Section has reviewed research findings relating to worker motivation, job performance and job satisfaction. It is evident that firm solutions to organization problems in this area are not available. Even more noticeable is the absense of literature dealing specifically with these problems as they relate to solid waste collection/disposal. Analyzing the results from available research investigations and suggestions in the literature, the following general conclusions are offered for solid waste collection/disposal operations:

1) Solid waste workers will attain higher levels of motivation with incentive programs,

2) Worker performance will be improved with proper job design,

3) Worker job satisfaction will be enhanced with improved motivation and performance,

4) An effective solid waste collection/disposal system would utilize group assignments (teams).

Results of incorporating these conclusions into the solid waste operations of the test City are included in Section 7.

SOCIOMETRIC ANALYSIS FOR CREW SELECTION

A team incentive approach was utilized in this research because the work group has considerable influence over productivity. The members of each work group must be able to interact favorably in order to increase their effectiveness. If tension and distrust exists among members of the team, then their effectiveness as a group will be diminished.

Typically, crew selection is conducted in a random manner without any regard as to crew preferences. Since the make-up of the work group is so critical to the success of any team incentive, employee preference was utilized as a basis for work group selection in this study. The method used for the selection of the crew and team work groups was the technique of sociometric analysis. The sociometric technique is a method for establishing work groups, based on employee preference, through the use of a simple questionnaire.

The employees of the test City were asked to choose other employees with whom they wanted to work and to choose employees with whom they did not want to work. Appendix 9.1 is a sample choice form and Appendix 9.2 is the cover letter that accompanied the choice forms. The raw data was then analyzed through the use of choice matrices. Figure 11 is an example of a matrix used to evaluate mutual choices by the Laborers. The actual results of the analysis is described in the subsequent paragraphs.

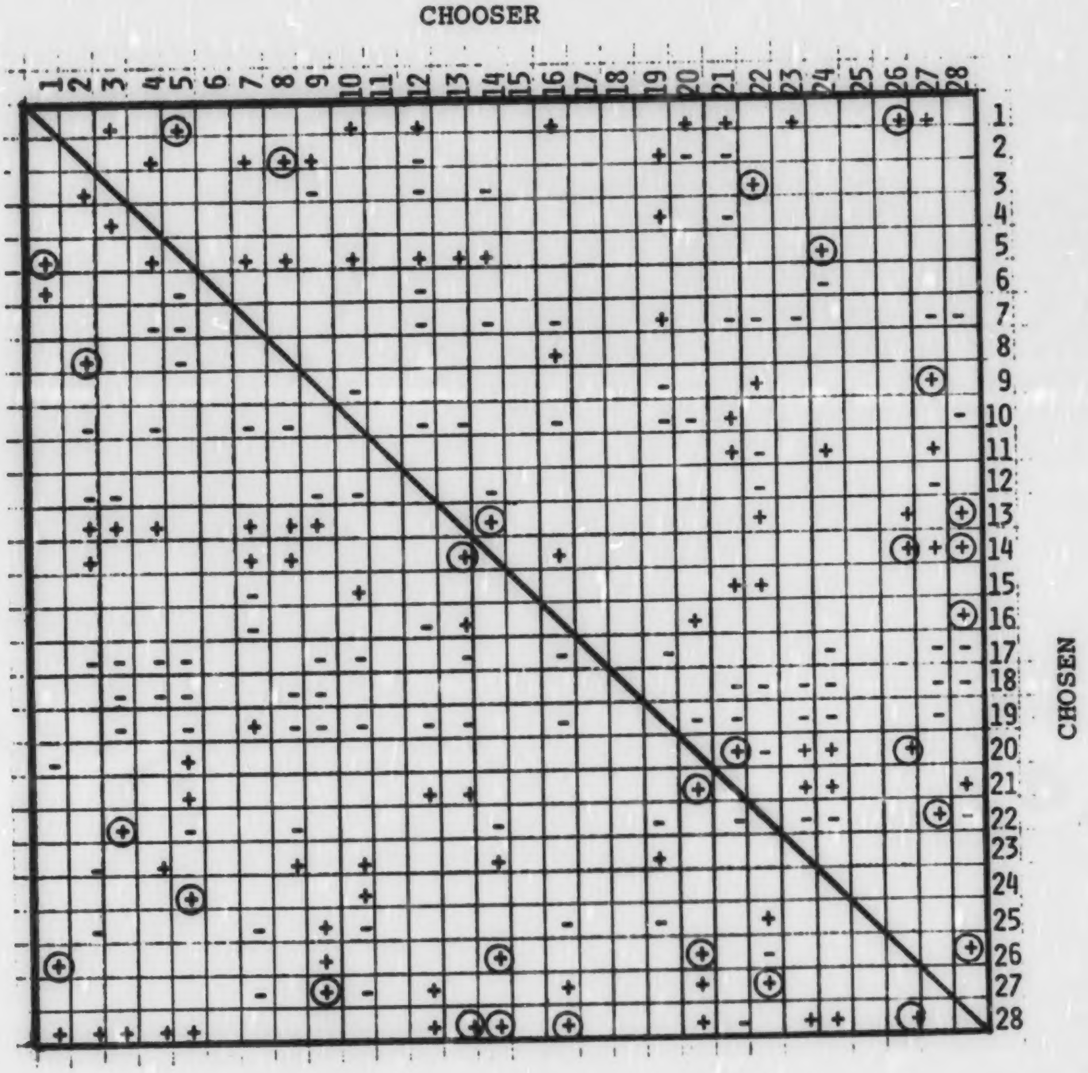
The purpose of this analysis was to recommend crews and teams based on employee preferences. Two teams were constructed, each with several three-man truck crews and foreman. The recommended team selection was based on the positive and negative choices of the Drivers and Laborers. Laborers were asked to choose other Laborers and Drivers. Drivers were asked to choose Laborers and other Drivers. All but one of the Drivers and twenty-two out of twenty-eight Laborers participated.

Four basic sets of data were examined:

1) Laborers choosing other Laborers
2) Laborers choosing other Drivers
3) Drivers choosing Laborers
4) Drivers choosing other Drivers

The four sets of data were individually tabulated on matrix coding forms to reveal preferences and to simplify the procedure.

Since the members of the three-man crews must work more closely together than the crews within a team, priority was given to crew selection over team selection.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+ DENOTES POSITIVE CHOICE

- DENOTES NEGATIVE CHOICE

○ DENOTES RECIPROCAL CHOICE

Figure 11. Sociometric Analysis Matrix

The following priorities were established:

1) Laborers choosing Laborers for crew selection
2) Laborers choosing Drivers and Drivers choosing Laborers for crew selection
3) Drivers choosing Drivers for team selection
4) Commercial and Large Item Pickup crew selection

Laborer-Laborer Matching

An attempt was made to maximize the number of matched pairs, that is, the number of Laborers who want to work with each other.

Results:
1) Seven of the eight Laborer crews are matched pairs.
2) One of the crews resulted from a one-way choice.
3) There are no negative choices in this group.

Laborer-Driver and Driver-Laborer Matching

An attempt was made to maximize the number of matched pairs between Drivers and at least one of the Laborers in a crew.

Results:
1) Six of the eight crews involved a matched pair between the Driver and at least one Laborer.
2) Two of the eight crews involve a one-way choice of Drivers by Laborers.
3) There are no negative choices in this group.

Driver-Driver Matching

An attempt was made to minimize the number of negative choices among the Drivers within each of the two teams.

Results:
1) On one there are no negative choices.
2) On the other team there is one negative choice.

Commercial and Large-Item Pickup Crew Selection

An attempt was made first to have a one-way choice between the Driver and the Laborer, and second to minimize negative choices between the Drivers of the commercial routes and the Drivers of the teams they are assigned to.

Results:
1) Both of the commercial crews involve a one-way choice between Laborer and Driver. The large-item crew involves neither a positive nor a negative choice.
2) There is one negative choice between the Driver of the commercial route and the other Drivers on one team; there are two negative choices on the other team.

The sociometric technique is an effective method for developing collection teams based on employee preference. The procedure is quite simple, yet the benefits derived from the standpoint of work group interaction are substantial. Figure 12 shows a typical crew of driver (center) and two laborers following implementation.

Figure 12. Three-Man Crew

FOOTNOTES

[1] Efforts to enhance the effectiveness of the use of the physical objects and facilities people use and to maintain or enhance certain desirable human values in this process is often referred to as "human factors engineering." The process of industrial job designing, with its many human and technical implications, is thoroughly treated by Ernest J. McCormick, *Human Factors Engineering*, McGraw-Hill, 1970; 3rd edition. The interested reader can also refer to Alphonse Chapanis, "On the Allocation of Functions Between Men and Machines," *Readings in Organizational and Industrial Psychology*, G. A. Yukl and K. N. Wexley, eds., Oxford University Press, 1971, pp. 521-30.

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4 PERSONAL CHARACTERISTICS AND ABSENTEEISM FOR SOLID WASTE COLLECTION WORKERS

INTRODUCTION

The purpose of this Section is to examine personal characteristics of individuals working in collection operations, and to determine relationships between certain employee demographic factors[1]* and worker absenteeism. The population investigated was comprised of blue collar employees permanently assigned to the collection and disposal of municipal solid waste in Covington, Kentucky.

Factors[2] relating to age, marital status, number of dependents, reported level of formal education, previous employment history, military service, height, weight, race and arrest record form a discernible pattern of characteristics which relate to the measures of absenteeism for this group of workers.

Information on race was not available on the majority of the employment application forms, in accordance with government regulations, but was provided by the solid waste management. Using all information, the absentee record and personal history profiles across two racial groups was examined.

Basic Manpower Issues in Solid Waste Management

According to a 1973 study by Applied Management Science, Inc. (AMS), "The solid waste management field in the United States consists of 227,000 people: 125,000 of whom are employed by the 10,678 private contracters, and 102,000 of whom work for the 2,982 municipal and county agencies."[3] It was estimated that 170,000 of these workers are assigned specifically to the collection task. "Absenteeism is important not only because of lost man-days, but also because it may reflect the worker's attitude toward his job and management's personnel policies. At the unskilled level of the solid waste field (laborers and drivers), the absenteeism rate is 6.2 days per man per year."[4]

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* References and footnotes at end of Section.

This figure would indicate that absenteeism in this work system is not a significant problem in general. However, there is "considerable variability in absenteeism among cities and this variance can be traced (in part) to diverse management policies."[5] For example, it is reported that Atlanta has an extremely high absenteeism (20 percent of work force off on a normal day, with as high as 40 percent on some Mondays). AMS concluded that "This absenteeism results from a system which permits such behavior; management penalizes people who are absent only by docking their pay. The management philosophy in Atlanta favors "job support" rather than efficiency so there are definite tendencies to be lenient with absenteeism and give unlimited chances to people who are absent frequently."[6]

In addition to absenteeism data, AMS noted differences in the turnover rates and crew sizes between public and private sector solid waste collection operations. "The high turnover rate observed among unskilled laborers is primarily voluntary. . . This suggests that the hard, physical working conditions at the lower levels are too severe for many, and they quit. This could also result from the relative dissatisfaction of unskilled workers with their jobs. The contrast between public and private systems shows higher turnover in the private sector at all job levels except management and supervisory personnel and great disparities at the skilled levels (8.5 percent for public, 21.4 percent for private) and unskilled levels (30.3 percent for public, 58.9 percent for private)."[7]

In the matter of crew size, AMS reports that the profit motive of the private sector drives management to minimize truck crew size, increase the number of tons of solid waste collected per man per day, as well as the number of tons collected per truck per day. Table 1 outlines typical differences between public and private waste collection/disposal systems.

General Descriptive Information

As shown in Table 2, there are approximately 227,000 persons employed in management of solid waste. Of this number, approximately 170,000 are involved in the collection function. In the public sector, 90,587 workers are classified as skilled and unskilled laborers out of a total of 101,892.

The high ratio of unskilled/skilled workers to management/supervisory/clerical personnel is indicative of the "labor intensiveness" found in certain local government functions. Labor intensiveness in the public sector is due in part to the stronger presence of unions, the notion of "job support" versus efficiency, and the tacit public sector objective of providing jobs, primarily at the unskilled level, as an alternative to having individuals placed on unemployment or overburdened relief

TABLE 1

PUBLIC/PRIVATE SECTOR COLLECTION COMPARISON

	Public Mean	Private Mean	Case Study Public Systems	
Men per Truck	2.5	1.6	3.0	Minneapolis
			4.1	Milwaukee
			4.5	Atlanta
Tons per Man per Day	3.0	6.1	2.5	Fort Worth
			2.0	Minneapolis
			1.9	Tacoma
			1.6	Milwaukee
			1.3	Atlanta
Tons per Truck per Day	7.6	9.1	5.7	Tacoma
			6.1	Minneapolis
			6.5	Milwaukee
			7.4	Fort Worth
			5.6	Atlanta

Source: Applied Management Science, Inc.: Manpower Profile and Analysis in the Field of Solid Waste Management (Vol. II), p. 8.1, Jan. 16, 1973.

roles. AMS notes that; "The basic policy to be faced . . . concerns the public sector's legitimate role as an employer of last resort or a transitional employer of the disadvantaged."[8]

Volume Managed and Health Considerations in Solid Waste Collection

There are two additional conditions that affect the solid waste collection worker. One is the volume of solid waste generated and collected; and secondly, the associated health hazards.

Each day, approximately 1.3 billion pounds of municipal solid waste[9] is generated in this country. This converts to approximately 6 pounds per citizen per day.[10] The cost to the public for this service is estimated at $5 billion annually. Typically, the average collection worker handles three to six tons of solid waste daily. For performing this work load, usually under less than desirable working and environmental conditions, the solid waste worker (laborer) can expect to earn an average of $111.00 weekly. For every job category except clerical/secretarial, employees in the private sector have a higher mean gross weekly salary than employees in the public sector.

TABLE 2

MANPOWER DISTRIBUTION BY JOB CATEGORIES

	Number Employed		
Job Categories	Total	Local Government	Private
Managerial	19,835	2,723	17,113
General	19,212	2,356	16,856
Other	623	367	257
Clerical	10,914	2,296	8,619
Super/Foreman:	11,470	6,286	5,177
Collection/ Transportation	9,395	5,078	4,323
Disposal/Other	2,075	1,208	854
Skilled Laborers:	99,791	36,243	63,591
Maintenance	8,967	2,179	6,788
Collection/ Transportation	80,046	27,193	52,873
Disposal/Other	10,803	6,871	3,930
Unskilled Laborers:	84,729	54,344	30,402
Collection/ Transportation	79,964	51,583	28,385
Disposal/Other	4,765	2,761	2,071
TOTALS	226,739	101,892	124,092

Source: Applied Management Science, Inc.: Manpower Profile and Analysis in the Field of Solid Waste Management (Vol. II), p. 19, Jan. 16, 1973.

In addition to the lower salary levels, typically workers in solid waste have limited opportunity for promotion and raises due to the absence of career ladders built into the organization structure. However, it should be noted that public sector employees have access to more non-direct financial benefits than private sector employees. These benefits often include: paid sick leave, contributory and/or non-contributory medical-surgical insurance, group life insurance and retirement plans.

Perhaps the most striking characteristic of employment in the solid waste field is the high rate of accidents experienced by solid waste workers and the degree of exposure to and incidence of occupation-related health problems. Review of accident or injury frequency rates indicates that solid waste collection exceeds that of all other occupations including logging and meat cutting. For example, in 1970 the rate was four times that experienced by coal miners, and nine times that of the average industrial worker. Nearly 25 percent of all injuries sustained are to the eye.[11] The most frequent health problems encountered include frostbite, falliculitus (caused by personal hygiene and over-dressing in inclement weather), and xerosis, as well as other common forms of occupational dermatosis. Gellin and Zavon note that, "The stigmata or occupational marks (bruises on legs and hands, etc.) were not sources of complaint . . . [but] were accepted by them [the solid waste workers] as 'badges of the trade'."[12]

Another health problem, centered mainly in high density urban areas, is the inhalation of carbon monoxide (CO) as a result of the workers being in the immediate vicinity of the sanitation trucks while performing their task. One study, conducted in New York City, found that: "There is no doubt that levels of carbon monoxide in the immediate vicinity of functioning sanitation trucks are excessive. These increased environmental working levels result in increased absorption of CO and cause a definite increase in the carboxy-hemoglobin levels of sanitation crews."[13] The study concluded that, "A significant number of men absorbed enough CO to raise their COH_6 levels to what is medically considered hazardous."[14]

CAUSES OF ABSENTEEISM

This subsection provides a brief analysis of the causes of absenteeism as related to workers in general. In addition to this information, a review of selected literature highlights relevant previous research regarding the relationship of demographic variables to worker absence.

The causes of absenteeism are as complex as its results. One cause is the level of job satisfaction. Vroom states that workers make daily decisions whether or not they will appear for work.[15] He notes that, "If, on a given day, the consequences expected from not working are more attractive than those expected from working, the worker would be predicted to be absent. The large number and the variable nature of the consequences of being present and being absent from work on a given day makes any precise determination of who will be absent, and when, unfeasible if not impossible . . . To the extent to which the worker derives satisfaction from participating in his work role, we would assume that there would be a force acting upon him to be present at work. It would seem to make little difference what characteristics of the work role are the source of these rewards. The only requirement is that the attainment of the rewards is dependent on being present at work."[16]

In addition to job satisfaction, worker attendance is affected by other intervening variables such as quality and style of management, concordance of goal structures, and availability of performance incentives.

Another way to approach the problem of absenteeism is to determine the relationships, if any, between certain employee demographic information, usually captured on a personal history document such as a standard employment application form, and the absentee records of persons presently employed in the primary work system. If there exists significant statistical relationships between several personal history factors and present absentee records, a predictive capability can be developed regarding the efficacy of recruiting and selecting individuals for inclusion in a performance-oriented work group.

Review of Existing Knowledge

A review of the existing knowledge on the subject of absenteeism reveals a limited amount of information as to the relationship between personal history or demographic factors and absenteeism.

Shepherd notes that, "Absence was higher for single men. Those with two dependents had a minimum of absences."[17]

Baumgartel and Sabol reported the results of their research on a population of 3,900 non-supervisory employees of a major U.S. airline.[18] There were two major objectives to the study: First, they tested the prediction that the larger the size of the location (or "Plant"), the higher the absenteeism. The investigation concluded that smaller organizations have less absenteeism. The second objective of the study was to determine how age, wage rate, seniority, and job classification were related to absenteeism. From analyzing a sub-sample of white collar women workers, the investigators concluded that a positive correlation did exist between absence frequency and the seniority, wage level, and age (length of time) on job. For blue collar men, the [common factor] age, "appears to bear a consistently flat relationship with absenteeism among the population."[19] The authors concluded that, "In contrasting the findings for blue collar workers with those of the other three groups, it can be concluded that age among production workers is not a markedly significant variable."[20]

Naylor and Vincent investigated job success criterion based on the age, marital status, and number of dependents of 220 female clerical workers.[21] The criterion of job success was absenteeism from work over a six-month period. The independent and dependent variables were dichotomized in the following manner:

Marital Status = Married or Single
Age = 32 or more; or less than 32
Number of Dependents = One or more; or none
Absent = 4 days or more; or less than 4 days

Using item correlation, multiple correlation, and Chi-square, the researchers reported that only one of the variables--the number of dependents--showed a significant relationship with absenteeism ($x^2 = 7.99$, dF = 1, r = 4.24).

In a related investigation, Scollay analyzed the responses of 200 employees to a group of personal history items in relation to the criterion of average salary increase.[22] Of these items, Scollay found 88 of 176 possible items to be significant at the 10% level (r = .15). He concluded that, "until further work has been done to prove their usefulness for individual prediction, personal history forms are at best an adjunct to the interview and test battery."[23]

In a subsequent report, Scollay used the information developed in the 1956 study to attempt a cross-validation of personal history data from a specific occupational group (sales managers) against the salary increase criterion.[24] A major departure in this study is the use of individuals from a homogenous occupational level, rather than selecting employees across occupational levels. Using the personal history data of 116 subjects, Scollay applied the triserial-r statistic developed by Jaspen to the weighted score. The result was that the "correlations are high enough to justify the assumption of success, [as] defined in this study, can be predicted on the basis of personal history items, whose validities were determined in a separate study with a different criterion."[25]

Minor used self-reported biographical data from standard employee application forms to construct a selection instrument which would enable prediction of probable tenure for female clerical applicants in an insurance company.[26] Employing a sample of 440 clericals, Minor labeled 11 of 32 predictor variables as being critical to tenure. These variables included: age at time of application; number of children; tenure on previous jobs; and marital status at time of application. Minor concluded that employee application blanks could be scored, and hiring made on the basis of a critical score below which the individual would not be hired. The decision for placement, however, would be made in light of extra-organizational considerations such as the level of current labor market conditions and the selection ratio necessary to fulfill organization needs.

Robinson utilized a weighted application blank to predict clerical turnover.[27] He found age, education, and marital status to be sensible and interpretable variables for differentiating between short-term and long-term employees.

WORKER ENVIRONMENT IN COVINGTON, KENTUCKY

Personnel data was obtained from Public Works Department records. As of January 1, 1974, there were 38 full-time blue collar employees (all Civil Service) directly engaged in collection and disposal. Of these 38, 12 were drivers (Laborer II), and 26 were "laborers" (collectors, Laborer I, II). Because of absenteeism, 13 temporary employees were assigned to the Public Works Department to fill in for absent workers. In 1973, the Covington work group collected approximately 26,000 tons of solid waste from approximately 19,000 dwelling units. This would mean that 8,000 pounds or 4 tons of solid waste material were handled per laborer per day. Comparing this figure to those in Table 1, Covington was above the national average (3.0 tons per man per day) in the amount of waste collected per worker.

The job classification of laborer and driver are defined under the rules and regulations of the Civil Service System of the City of Covington. As an employee under this system, the worker is entitled to 12 days excused sick leave per year. Those days not used in any calendar year will be accrued until such time as the employee has earned a total of 240 days. At the time of retirement he will receive a lump sum remuneration for these days equivalent to 200 working days. In the event of death immediately prior to or following retirement, the widow of the deceased employee will receive a lump sum payment equivalent to the full 240 days of sick leave.

In addition to allowed sick leave, the employee may be absent from work on legal holidays. If emergency holiday work is scheduled, the worker receives 1-1/2 or double time rate, depending on the holiday. If the employee works on the following days, he earns 1.5 times the normal rate:

- Franklin D. Roosevelt's birthday (January)
- Abraham Lincoln's birthday (February)
- George Washington's birthday (February)
- Memorial Day (May)
- Independence Day (July)
- Labor Day (September)
- Columbus Day (October)
- 1/2 day for Good Friday

On the following holidays, he earns double the normal rate:

- New Year's Day (January)
- Thanksgiving Day (November)
- Christmas Day (December)

This list of legal holidays represents 10.5 days the employee could be away from the job. In addition, each employee earns the right to paid vacation days which are determined by length of service:

10 working days	18 employees
13 working days	9 employees

15 working days	3 employees
20 working days	5 employees
	35

Weighted Average, $\bar{x}$ = 12.5 days/man

Out of the 260 working days in the year, the average worker may miss 12 + 10.5 + 12.5, or 35 days work with pay annually. When added to the number of days absent due to injury, or other reasons, the total days missed represents a sizeable portion of the work year.

The hourly wage rate for laborers and drivers was between $3.36 and $3.96 as outlined below:

Labor Class II

Step 1, @ $3.36 = 2 employees
Step 2, @ $3.63 = 8 employees
Step 3, @ $3.69 = 25 employees

x = $3.65 per hour or $146.00 per week (higher than the national average of $111.00 per week)

In addition to the prevailing wage rate, the employees are entitled to a comprehensive benefit package, most of which is non-contributory.

METHODOLOGY OF INVESTIGATION AND VARIABLE IDENTIFICATION

For the 35 workers analyzed, total absenteeism averaged 22.7 days per man during calendar 1973, nearly 4 times the national average of 6.2 days. Of this total, 11.6 days were identified as being unexcused absences. The objectives of this area of the investigation are to:

1) Determine if an employee's age, marital status, number of reported dependents, and education at the time of application are related to present absenteeism.

2) Determine if previous behavior characteristics such as criminal arrest, present (at time of application) indebtedness, discharge from previous employment (for cause; i.e., fired), number of jobs held prior to application, previous experience with absenteeism as a result of illness, and experience with military service have any relationship to present absenteeism.

3) Determine if other personal characteristics such as height, weight, and race have any relationship to present levels of absenteeism.

Data Collection

The data for this investigation was collected through a census of pre-employment application forms for workers presently employed as of January 1, 1974. Additional information including absenteeism, injury, and available sicktime was provided by management. In addition, a series of interviews with management personnel provided information on mission, means, and characteristics of the task function.

Of the 38 men employed in the system, the data for 3 of the workers was incomplete and was therefore not included in the analysis. Analysis of the data for the remaining 35 workers included:

1) The mean and standard deviation of each variable were computed.

2) A series of regression analyses were performed to predict the variability in the dependent variable (absentee rate/score) based on its convariance with all the independent variables.

Descriptive Statistics and Variable Identification

For the purpose of analysis and interpretation, the assignment of variable codes to demographic data is as follows:

Var 1: Chronological age at the time the application is submitted to the City.

Var 2: Age of the employee as of 12/31/73

Var 3: Marital status of the employee as reported at the time of application

Var 4: Number of dependents as of data of application

Var 5: Record of arrest, at time of hire

Var 6: Record of employee having been terminated (fired) from employment position prior to date of application

Var 7: Record of financial indebtedness reported at time of application

Var 8: Record of work time missed during two years previous to date of application

Var 9: Weight (in pounds) of the employee as reported at date of application

Var 10: Height (in inches) of the employee as reported at date of application

Var 11: Level of education reported by the employee at date of application

Var 12: Record of military service as reported on date of application

Var 13: thru Var 16: Number of jobs previously reported held by employee at date of application

Var 13	Var 14	Var 15	Var 16
0	0	0	0 = 1 job
0	0	0	1 = 2 jobs
0	0	1	0 = 3 jobs
0	1	0	0 = 4 jobs
1	0	0	0 = 5 jobs

The number of jobs reported is limited to 5 due to the construction of the employment application form.

Var 17: Race of applicant

Variables 18 through 24 were used independently as criterion variables during the analysis of data, other than descriptive statistics.

Var 18: Number of sick days employee has accrued as of 1/1/74

Var 19: Number of days the employee was absent as a result of reported illness during 1973

Var 20: Number of days employee was away from his job due to unexcused absence

Var 21: Number of days employee was absent as a result of job-related injury

Var 22: Number of days employee was absent for other reasons, such as jury duty, or death in family.

Var 23: Total number of days employee was absent from work during 1973

Var 24: Number of sick days employee had accrued as of 1/1/74

RELATIONSHIPS BETWEEN DEMOGRAPHIC CHARACTERISTICS AND ABSENTEEISM

The descriptive statistics of each variable for the 35 workers are as follows:

		MEAN	STD. DEV.	LOCKE	
				x	σ
Var 1:	Age at time of application	27.4 yrs.	6.5 yrs.		
Var 2:	Age at present	34.1 yrs.	9.0 yrs.	33.8	11.5
Var 9:	Weight	168.8 lbs.	26.6 lbs.		
Var 10:	Height	69.9 in.	2.7 in.		
Var 11:	Education	10.0 yrs.	1.8 yrs.	9.5	2.8
Var 4:	Number of dependents (for married & widowed only)	4.0 dep.	2.8 dep.		

The above figures designated as "Locke" are from the results of a recent comprehensive investigation into the sources of satisfaction and dissatisfaction among solid waste employees made by Edwin A. Locke and R.J. Whiting of the University of Maryland (personal communication). The study encompassed 3,327 public and private waste collection/disposal agencies drawn from a stratified random sample. From these agencies, 911 solid waste employees (629 blue collar) were interviewed concerning job attitudes. The research indicates that blue collar waste management employees were less satisfied with their work than white collar, but were more satisfied than employees at the same job levels in other types of work.

Var 3: Marital Status:

Single = 12 (30 percent)
Married = 21 (65 percent)
Divorced/Separated = 2 (5 percent)

Var 13
thru
Var 16: Number of Jobs Reported Held

1 job = 23 percent
2 jobs = 22 percent
3 jobs = 25 percent
4 jobs = 22 percent
5 jobs = 8 percent

Var 5:	Arrest	= 47 percent
Var 6:	Fired	= 11 percent
Var 7:	Debt	= 5 percent
Var 8:	Reported Illness (None)	= 88 percent
Var 12:	Military Service	= 40 percent
Var 17:	Race -	
	White	= 69 percent
	Black	= 31 percent

Among the Dependent Variables, the statistical analysis reveals:

		MEAN	STD. DEV.	RANGE (Days)
Var 18:	Sick days, accrued 1973	18.7	14.3	1-72
Var 19:	Days excused absence	9.4	5.6	1-22
Var 20:	Days unexcused	11.6	15.1	0-72
Var 21:	Days absent--injury	1.7	6.0	0-35
Var 22:	Other absences	.08	.5	0-3
Var 23:	Total days absent	22.7	18.3	2-91
Var 24:	Sick days accrued 1974	21.1	15.1	5-79

Variable 23 indicates that the average number of days missed due to excused or unexcused absenteeism was 22.7, or more than one month per year. Of this amount, an average of 11.6 days (Var 020) were categorized as unexcused. At an average hourly wage rate of $4.65, the average worker is losing approximately $340 per year in gross wages as a result of unexcused absenteeism.

Descriptive Statistics by Race

Table 3 provides information on demographic characteristics by race. According to this information, the average black worker is slightly older, less educated, more likely to be married and have an arrest record. In addition, the average black worker has more total days absent, more days absent without pay, and more days absent as a result of work related injury. Caution should be exercised to the significance of this information because of the large standard deviations associated with variable averages.

Tests for Statistical Significance: All Workers (N=35)

Table 4 illustrates the coefficients of correlation between eight personal history characteristics and each of the measures of absenteeism. The Table reveals that there is a significant correlation between the marital status of the worker and the number of days absent (excused) for reasons other than sickness or injury. It can be concluded that absence for other reasons will be greater among married workers than among non-married

TABLE 3

DEMOGRAPHIC CHARACTERISTICS BY RACE

		WHITE		BLACK	
		$\overline{x}$	σ	$\overline{x}$	σ
Var 001	Age at time of application	26.5 yrs.	6.9 yrs.	29.5 yrs.	5.4 yrs.
Var 002	Age at present	32.3 yrs.	8.7 yrs.	38.0 yrs.	8.7 yrs.
Var 009	Weight	164.7 lbs.	28.4 lbs.	177.8 lbs.	20.4 lbs.
Var 010	Height	69.4 in.	2.7 in.	69.7 in.	2.7 in.
Var 011	Education	10.6 yrs.	1.9 yrs.	9.8 yrs.	1.5 yrs.
Var 003	Marital Status:				
	Single (9 people)	42.0 percent			
	Single (2 people)			18.0 percent	
	Married (13 people)	54.0 percent			
	Married (8 people)			73.0 percent	
	Div./Sep. (1 person)	4.0 percent			
	Div./Sep. (1 person)			9.0 percent	
Var 004	No. of Dependents (Married only) $\overline{x}$ =	3.6		3.6	
Var 013 thru Var 016	No. of Previous Employers				
	1 job	16.0 percent		28.0 percent	
	2 jobs	13.0 percent		0.0 percent	
	3 jobs	21.0 percent		27.0 percent	
	4 jobs	25.0 percent		27.0 percent	
	5 jobs	25.0 percent		18.0 percent	
Var 005	Record of Arrest	42.0 percent		55.0 percent	
Var 006	Report of Being Fired	8.0 percent		18.0 percent	
Var 007	Debt	8.0 percent			
Var 008	Reported Illness	1.3 days			
Var 012	Military Service	38.0 percent		45.0 percent	
Var 018	No. of Days Avail. (1973)	16.5	10.4	23.5	22.5
Var 019	No. of Days Excused Absence	8.8	6.0	10.5	4.7

		WHITE		BLACK	
		$\bar{x}$	σ	$\bar{x}$	σ
Var 020	No. of Days Unexcused Absence	10.1	14.9	15.0	10.5
Var 021	No. of Days Absent-Injury	.9	1.63	3.3	10.5
Var 022	No. Other Absences	0.0	0.0	.27	.9
Var 023	Total Days Absent	19.8	18.8	29.1	16.1
Var 024	No. of Days Avail. (1974)	19.9	10.4	23.6	22.7

TABLE 4

CORRELATION COEFFICIENTS OF PERSONAL CHARACTERISTICS AND MEASURES OF ABSENTEEISM

	# OF SICK DAYS ACCRUED (1973)	# OF DAYS EXCUSED ABSENCE (SICK)	# OF DAYS UNEXCUSED ABSENCE	# OF DAYS ABSENT DUE TO INJURY	# OF DAYS OTHER	TOTAL ABSENT	TOTAL AVAIL. (1974)
Age at time of application	.174	.274	-.138	.049	.015	-.013	.094
Age at present	.325	.340*	-.109	-.024	-.002	.006	.223
Marital status	.048	.089	.244	-.052	.681**	.230	.043
Number of Dependents	.235	.426*	.055	.166	-.135	.226	.058
Weight	-.010	.032	.082	-.019	.021	.072	-.067
Height	-.209	-.174	.293	-.062	-.133	.164	-.188
Education	-.313	-.261	.059	-.057	-.129	-.053	-.207
Race	-.218	-.143	-.153	-.186	-.253	-.238	-.115

* significant at $\alpha = 0.05$

** significant at $\alpha = 0.01$

workers. This may mean that work missed was due to death in the spouse's family, demands for care of children, or other family reasons. The Table also indicates that there is a significant relationship between the number of dependents reported at the time of hire and the number of days absent due to excused illness. Therefore, it may be generally concluded that the more dependents a worker has the more he can be expected to be absent as a result of reported illness. This could indicate the exposure of the worker to communicable diseases as a result of the interaction of his family with others would make him more prone to being absent from work as a result of being exposed to and contracting common illness such as colds, or flu.

It is also important to note that race has no relationship to absenteeism in this work system, nor does education, height, weight, or age at the time of hire. However, there is a statistically significant relationship between present age and the number of days absent as a result of excused absence. This may mean that younger workers are more sturdy, or less prone to job affecting illness, or it may be an indication that older workers with many dependents are using excused (paid) sick leave in order to care for the needs of their families.

Table 5 illustrates the coefficient of correlation between six previous experience characteristics and each of the measures of absenteeism. The Table reveals only one previous experience characteristic, having had five previous jobs, to be related to a measure of absenteeism in a statistically significant manner. It should be noted at this point that the attitude of the worker and management in the test city was that the sick leave permitted with pay is an earned right that should be exercised regardless of whether or not the employee is actually sick. For this reason it is extremely difficult, all other things being equal, to draw conclusions as to the significance of the relationships with the independent variables.

Tests for Statistical Significance: White Workers (N=24)

Table 6 illustrates the coefficients of correlation between the eight personal history characteristics of the white workers and their relationship to each of the measures of absenteeism. The Table reveals more significant statistical relationships than when all workers, black and white, are analyzed as a group. There is a significant relationship between the present age of the worker and the number of days absent as a result of using paid sick leave. It can be concluded that the time off the job due to reported sickness will increase with the white worker's age. As can be expected, the relationship between the number of dependents and the incidence of sick leave are also positively correlated.

TABLE 5

CORRELATION COEFFICIENTS OF PREVIOUS EXPERIENCE CHARACTERISTICS AND MEASURES OF ABSENTEEISM (N=35)

	# OF SICK DAYS ACCRUED (1973)	# OF DAYS EXCUSED ABSENCE (SICK)	# OF DAYS UNEXCUSED ABSENCE	# OF DAYS ABSENT DUE TO INJURY	# OF DAYS OTHER	TOTAL ABSENT	TOTAL AVAIL. (1974)
Record of Arrest	.289	-.009	-.286	.170	-.157	-.187	.278
Record of Previous Job Termination	.043	-.218	.003	-.101	-.062	-.099	.130
Record of Debt	-.019	.117	.006	-.069	-.042	.017	-.059
Work Missed due to Illness	-.041	.104	.015	-.071	-.047	.019	-.077
Military Service	.059	.282	-.035	-.200	.210	-.001	-.061
Previous Employment:							
2 jobs	.176	-.159	.091	-.072	-.093	.000	.247
3 jobs	.053	-.039	-.020	-.110	-.101	-.068	-.009
4 jobs	-.002	.025	.041	-.107	.315	.015	-.073
5 jobs	-.055	.348*	.097	-.017	-.053	.179	-.181

* significant at $a = 0.05$

TABLE 6

CORRELATION COEFFICIENTS OF PERSONAL CHARACTERISTICS AND MEASURES OF ABSENTEEISM AMONG WHITE EMPLOYEES (N=24)

	# OF SICK DAYS ACCRUED (1/73)	# OF DAYS EXCUSED ABSENCE (SICK)	# OF DAYS UNEXCUSED ABSENCE	# OF DAYS ABSENT DUE TO INJURY	# OF DAYS OTHER	TOTAL ABSENT	TOTAL AVAIL. (1/74)
Age at time of Application	.245	.339	-.182	-.192	***	-0.052	.099
Age at Present	.362	.396*	-.107	-.240	***	.021	.231
Marital Status	.189	.039	-.125	-.161	***	-.101	.231
Number of Dependents	.282	.557**	.166	-.261	***	.289	-.029
Weight	-.001	-.093*	.124	.139	***	.081	.015
Height	-.495*	-.164	.438*	.177	***	.311	-.498**
Education	-.367	-.252	-.121	-.164	***	.001	-.281

* significant at $\alpha = 0.05$

** significant at $\alpha = 0.01$

*** coefficient of correlation cannot be computed

In this white work group sub-sample, there is a positive relationship between the height of the worker and the number of days of unexcused absence. The Table indicates this relationship is significant at the $\alpha = 0.05$ level and is therefore significantly related to the number of days accrued by the worker at the beginning of the 1973 and 1974 work years. Although this could be a spurious correlation, there is possible medical significances associated with this finding. For example, it may be the case that for taller workers more strain is placed on the back and spine as a result of the inadequate leverage when lifting the solid waste containers. The Table further indicates that no statistically significant relationship exists among the remaining personal characteristics of white workers and the various measures of absenteeism.

Table 7 displays the coefficient of correlation between previous experience characteristics of white workers and the various measures of absenteeism. There is a statistically significant inverse relationship at the $\alpha = 0.05$ level between the record of previous job terminations and the number of days absent due to excused sickness. From this it can be predicted that the worker who has been previously terminated from a place of employment is likely to miss fewer work days as a result of sickness. Table 7 also reveals a relationship between the number of previous jobs the worker had reported and two measures of absenteeism.

Tests for Statistical Significance: Black Workers (N=11)

Table 8 illustrates the coefficients of correlation between the eight personal characteristics of the black solid waste worker and measures of absenteeism. As was the case in the previous analyses, the marital status of the worker has a statistically significant relationship to several measures of absenteeism. There is a positive relationship between marital status and the number of days unexcused absence, at the $\alpha = 0.01$ level, number of days absent for other excused, and with the total number of absences. As is the case in all instances, no causality can be associated as a result of the correlation of variables.

Table 9 reveals an interesting relationship among variables in the form of the record of arrest and the number of unexcused absences. In this sub-population, there is an inverse relationship between the incidence of arrest and the worker being away from the job for unexplained or unexcused reasons. However, there is also another relationship that is statistically significant. This is the positive relationship between the incidence of military service and the number of days missed due to excused sickness.

Finally, Table 9 also reveals significant statistical relationships between the number of jobs previously held by the black worker and the excused absences and total days available.

TABLE 7

CORRELATION COEFFICIENTS OF PREVIOUS EXPERIENCE CHARACTERISTICS AND MEASURES OF ABSENTEEISM AMONG WHITE EMPLOYEES (N=24)

	# OF SICK DAYS ACCRUED (1/73)	# OF DAYS EXCUSED ABSENCE (SICK)	# OF DAYS UNEXCUSED ABSENCE	# OF DAYS ABSENT DUE TO INJURY	# OF DAYS OTHER	TOTAL ABSENT	TOTAL AVAIL. (1/74)
Record of Arrest	.127	-.048	-.178	-.061	***	-.162	.194
Record of Previous Job Terminiation	-.265	-.400*	-.063	-.172	***	-.194	-.043
Record of Debt	.031	.162	-.039	-.172	***	.068	-.073
Work Missed Due to Illness	-.001	.150	-.164	.054	***	.077	-.099
Military Service	-.043	.124	-.116	-.281	***	-.077	-.072
Previous Employment							
2 jobs	.012	-.082	0.273	.089	***	.198	.049
3 jobs	.200	-.033	-.161	-.029	***	-.141	.238
4 jobs	-.435*	-.229	-.066	-.037	***	-.129	-.320
5 jobs	-.017	.438	.161	.098	***	.277	-.293

* significant at $\alpha = 0.05$.

*** coefficient of correlation cannot be computed.

TABLE 8

CORRELATION COEFFICIENTS OF PERSONAL CHARACTERISTICS AND MEASURES OF ABSENTEEISM AMONG BLACK EMPLOYEES (N=11)

	# OF SICK DAYS ACCRUED (1/73)	# OF DAYS EXCUSED ABSENCE (SICK)	# OF DAYS UNEXCUSED ABSENCE	# OF DAYS ABSENT DUE TO INJURY	# OF DAYS OTHER	TOTAL ABSENT	TOTAL AVAIL. (1/74)
Age at time of application	.023	-.087	-.166	.133	-.090	-.116	.056
Age at Present	.235	.079	-.295	-.072	-.153	-.317	.216
Marital Status	-.111	.146	.789**	-.081	.989**	.806**	-.123
Number of Dependents	.189	-.132	-.344	.456	-.389	-.093	.158
Weight	-.184	.380	-.183	-.227	-.095	-.219	-.301
Height	.029	-.248	-.052	-.204	-.281	-.271	.097
Education	- 0.248	-.193	.0167	.028	-.176	-.032	-.123

* significant at $a = 0.05$

** significant at $a = 0.01$

TABLE 9

CORRELATION COEFFICIENTS OF PREVIOUS EXPERIENCE CHARACTERISTICS AND MEASURES OF ABSENTEEISM AMONG BLACK EMPLOYEES (N=11)

	# OF SICK DAYS ACCRUED (1/73)	# OF DAYS EXCUSED ABSENCE (SICK)	# OF DAYS UNEXCUSED ABSENCE	# OF DAYS ABSENT DUE TO INJURY	# OF DAYS OTHER	TOTAL ABSENT	TOTAL AVAIL. (1/74)
Record of Arrest	.456	.029	-.593*	.298	-.346	-.387	.381
Record of Previous Job Terminiation	.218	.048	.048	-.154	-.149	-.049	.237
Record of Debt	***	***	***	***	***	***	***
Work Missed Due to Illness	***	***	***	***	***	***	***
Military Service	.138	.707**	.094	-.298	.345	.125	-.078
Previous Employment:							
2 jobs	.449	-.375	-.303	.154	-.149	-.509	.533*
3 jobs	-.329	-.075	.262	-.199	-.194	.089	-.246
4 jobs	.374	.658**	.221	-.199	.516	.302	.133
5 jobs	***	***	***	***	***	***	**

* significant at $a = 0.05$

** significant at $a = 0.01$

*** coefficient of correlation cannot be computed.

Step-Wise Regression

Step-wise regression is utilized to select the independent variables that provide the best prediction. The significance of the regression-coefficient variable is measured by the F statistic. If the F statistic is insufficient, the regression sequencing terminates. The formula for this is represented as follows:

$$Y = b_0 + b_1x_1 + b_2x_2 + \ldots b_nx_n$$

where:

Y = dependent variable
b_0 = constant term
b_n = b value of the nth independent variable

The equation for each of the following dependent variables is as follows:

1) Var 018: No. of Days Available, 1973
(10 percent level of significance)

$$\begin{aligned} Y_{18} = {} & 4.79\ (\text{days}) + 0.46\ (\text{Var } 004) + [-.216(\text{Var } 011)] + \\ & [-4.18(\text{Var } 006)] + 4.99(\text{Var } 013) + \\ & [-3.31(\text{Var } 005)] + .09(\text{Var } 018) + [-2.48(\text{Var } \\ & 016)] + .12(\text{Var } 002) + [-0.81(\text{Var } 017)] + \\ & .01(\text{Var } 009) \end{aligned}$$

Due to similarity of the dependent variables, the detail results of step-wise regression is shown only for Var 020, the number of unexcused absences, and Var 023, the number of total absences.

2) Var 020: Number of Unexcused Absences
(10 percent level of significance)

$$\begin{aligned} Y_{20} = {} & -135.15 + 0.24(\text{Var } 010) + 2.41(\text{Var } 003) + \\ & [-4.74(\text{Var } 005)] + 1.34(\text{Var } 004) + \\ & [-0.63(\text{Var } 001)] + 8.69(\text{Var } 013) + \\ & [-6.07(\text{Var } 017)] + [-0.14(\text{Var } 018)] \end{aligned}$$

3) Var 023: Total Number of Absences
(10 percent of significance)

$$Y_{23} = 29.1 + -9.3(\text{Var } 017)$$

where: Var 017 = Race and $\begin{matrix} 1 = \text{White} \\ 0 = \text{Black} \end{matrix}$

From this equation it may be concluded for the test City that the average white worker was absent approximately 20 days per year. The average black worker was absent approximately 29 days during the year.

CONCLUSIONS

In general, the investigation provided affirmative evidence as to the existence of statistically significant relationships between the following personal and previous experience characteristics of the solid waste collection workers in the test City and various measures of absenteeism. The most important characteristics are:

1) Age: It appears that the presumption that younger workers are more likely to be absent from work does not hold in this work system. In fact, it was indicated that as age increases, the number of days missed due to illness increases. This may be due in part to the demanding physical nature of the work itself or to increased family responsibilities.

2) Number of Dependents: From the analysis conducted, it appears that the more dependents the solid waste worker has, the more likely he is to be absent from work due to excused illness. This may be a result of the increased opportunity to contract communicable illnesses from members of his family, or it may be the case that the large number of dependents who are themselves ill require the worker's attention and he exercises his option to use 12 days per year paid sick leave to manage this off-the-job responsibility.

3) Race: From the step-wise regression, the average white worker in the test city was absent approximately 20 days annually, while the average black worker was absent approximately 29 days annually.

Recommendations

The following recommendations for personnel administration are suggested:

1) That information provided to the city as a result of the prospective employee completing the application form be verified in full regarding those elements that may affect absence behavior, i.e., arrest and previous employment.

2) That incentives be initiated to reduce absenteeism.

3) A change be made in the recruitment and testing of solid waste personnel that provides management with more effective decision information regarding their selection. One example of this change would be to eliminate from the employment application form

requests for information that are ineffective as inputs into management's decision process. For example, the question of previous illness, and/or the incidence of debt.

FOOTNOTES

[1] Personal history data submitted at the time of job application.

[2] At the time of application and as of 12/31/73.

[3] Cited in Manpower Profile and Analysis in the Field of Solid Waste Management (Vol. 1), by Applied Management Science, Inc. (unpublished manuscript prepared for U.S. Environmental Protection Agency under Contract No. 68-03-0041), 1973, p.4.

[4] IBID, p. 7.

[5] IBID, p. 7.

[6] IBID, p. 7.

[7] IBID, p. 7.

[8] IBID, p. 16.

[9] Municipal wastes include residential, commercial, demolition, street and alley sweeping, and miscellaneous.

[10] First Report to Congress, Resource Recovery and Source Reduction, 3rd Ed., U.S. Environmental Protection Agency, 1974.

[11] Gellin, Gerald A. and Zavon, Mitchell R., "Occupational Dermatosis of Solid Waste Workers," ARCH Environmental Health, Vol. 20, April, 1970, pp. 510-515.

[12] IBID, P. 151.

[13] Cimino, Joseph A. and Raab, Richard, "Study of the Carbon Monoxide Emission from Sanitation Trucks and Levels of Carboxyhemoglobin in Workers" (Environmental Protection Administration: New York City, October 1967).

[14] IBID, p. 9.

[15] Vroom, Victor H., Work and Motivation, John Wiley and Sons, Inc., New York, 1964.

[16] IBID, p. 178.

[17] Shepherd, W.J., "Absence from Work in Relation to Wage Level and Family Responsibility," Journal of Industrial Medicine, 1958, Vol. 15, 53-61.

[18] Baumgartel, Howard and Sabol, Ronald, "Background and Organizational Factors in Absenteeism", Personnel Psychology, 1959, Vol. 12, pp. 431-443.

[19] IBID, p. 439.

[20] IBID, p. 440.

[21] Naylor, James C. and Norman L. Vincent, "Predicting Female Absenteeism," Personnel Psychology, 1959, Vol. 12, pp. 81-84.

[22] Scollay, R.W., "Validation of Personal History Items Against a Salary Increase Criterion," Personnel Psychology, 1956, Vol. 9, pp. 325-335.

[23] IBID, p. 335.

[24] Scollay, R.W., "Personal History Data as a Predictor of Success"; Personnel Psychology, 1957, Vol. 10, pp. 23-26.

[25] IBID, p. 26.

[26] Minor, Frank J., "The Prediction of Turnover of Clerical Employees"; Personnel Journal, Vol. 51, May, 1963, pp. 393-402.

[27] Robinson, David D., "Prediction of Clerical Turnover in Banks by Means of a Weighted Application Blank"; Journal of Applied Psychology, Vol. 56, No. 3, 1972, p. 282.

5 WORK MEASUREMENT

TECHNIQUES AVAILABLE

In general, the work measurement techniques available for establishing time standards for manual work include judgement of management, historical records, observation time study, work sampling, and predetermined motion-time systems.

The management judgement techniques considers the influence of variables directly affecting the time required to perform the task in question. It also considers, by the very nature of judgement, many extraneous variables that influence actual time. The judgement technique, for this reason, is not regarded as accurate or consistent.

Historical records suffer from the same shortcomings as management judgement, and neither technique offers a sound basis for methods improvements. For example, in waste collection, records of truck time out and in are not sufficient to calculate work content time standards.[1]*

Observation time study, while more scientific than the methods discussed above, also relies on judgement when a performance rating factor is applied to the average actual time to obtain the normal time. This technique is more consistent than historical and judgement techniques and can be used for analysis of most waste collection activities.

Work sampling, a statistically sound technique, can produce accurate results. Random observation work sampling is useful for longer cycle supportive types of solid waste collection/disposal operations, e.g., landfill and garage activities. Short interval systematic sampling is useful to determine avoidable and unavoidable delays in the collection process. Work sampling does not lend itself to the microscopic measurement and analysis of short cycle, highly repetive elements which are prevalent in curbside collection activities.

A predetermined motion-time system, e.g., MTM, or Work Factor is recommended to perform analysis and measurement of detailed collection activities at curbside.

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*References and footnotes at end of section.

APPLICATION OF TECHNIQUES

A study was completed by Quon, Charnes, and Wersan[2] to simulate collection in Winnetka, Illinois. Their main objective was to predict the effect of changes in truck capacity, service density (stops/mile), waste at a stop, and haul distance on collection efficiency. Historical data for 43 truck trips was used for one service density. Haul velocities were obtained from a prior California study. Much of this work was used in a later study by Truitt, Liebman and Kruse[3,4] to devise mathematical models for calculating collection times in the northwest quadrant of Baltimore. The deficiencies of this study included its concentration on short range objectives, lack of ability to predict the impact of new collection methods, and no development of collection areas. Both the Winnetka and Baltimore studies were based entirely on limited historical data. Several other investigations[5,6,7] have also relied on historical data.

A project was completed by Wyskida[8,9] to determine solid waste collection routes for Huntsville, Alabama. Three types of block-by-block information were obtained for route development:

1) Time the collection crew expends from the beginning of one block to the end of the same block,

2) Street identification,

3) Travel time required for the collection vehicle to move to and from various segments of the City and the landfill.

Collection times were recorded for approximately 5000 blocks by field timing, thus eliminating the use of historical techniques, and obtaining much improved results over previous work. Average collection times were then calculated by type of collection customer within four defined City zones.

In 1969, Stone[10] completed a study to compare the efficiencies of one-, two- and three-man crews for collecting residential solid waste. Field observations were conducted of the collection process in four municipal systems and two private systems in Southern California. This data provided a basis for establishing time standards, and was used to simulate the collection of a given route by a single truck and crew. The report recommended that additional studies expand the use of engineered work measurement for evaluating waste collection.

Between 1969 and 1970, Xenia, Ohio[11] applied work measurement to assist in the redesign of collection routes. Individual routes were designed to require 320 to 420 minutes of daily collection time (5.3 to 7.0 hours). One minute was allowed for each residential customer, and an average collection time for each commercial customer was individually measured. One-quarter of a minute was deducted from each stop not requiring backdoor pickup, and one-tenth of a minute was deducted if plastic bags were used.

More recent work by Shell and Shupe[12] developed a computerized model to predict work content for residential waste collection in Cincinnati, Ohio. The total start and completion time was divided into five major elements.

1) Time out and in from the garage

2) Time for truck travel to and from and time at the disposal site

3) Time at individual stops

4) Time for double sided collection

5) Time for travel between stops.

Limitations for this investigation were:

1) Field work measurement was not completed for all time elements

2) Since no detail stop-by-stop waste generation and container data was available, work content within a given sub-district was averaged among the total number of assigned crews.

The most useful waste collection standards require that work content for individual intersection-to-intersection times be computed using appropriate work measurement and stop-by-stop waste generation data.[13,14]

WORK SAMPLING FOR SOLID WASTE COLLECTION ACTIVITIES

The work-sampling field study was designed to randomly observe collection activities throughout the City of Covington. Travel activities to and from the disposal site and garage were excluded from the study. After surveying the City, it was determined that certain delays would be dependent upon the type of area in which the data were gathered. For this reason, Covington was classified into three general area types.

The first type was the Residential--single unit (SRES) as illustrated in Figure 13. This includes both city and suburban

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Figure 13. Residential, Single Unit

areas in which the single family dwelling is the predominant type of housing. A characteristic of this type of area is the necessity of one stop for each individual family unit, and mostly off-street parking.

The second area type is the Residential--multi-unit (MRES) as illustrated in Figure 14. Under this category is found those areas in which the multi-family housing units are the major type of dwellings. This includes housing projects and apartment buildings not included on commercial collection routes. A characteristic of this type of area is the ability to often collect in one stop the solid waste of several family units.

The final area included in the study is the downtown area (DTWN) as illustrated in Figure 15. Within this category are found those housing units in the downtown area and the smaller businesses that are not collected on commercial routes. The percentages total samples taken in each area type were:

SRES	52.05%
MRES	21.51%
DTWN	26.44%

When making the observations in each area an estimate was made of parking and traffic conditions, and the amount of delay

Figure 14. Residential, Multi-unit

based on the following four-point scale:

None = 1.0 Medium = 3.0
Light = 2.0 Heavy = 4.0

The weighted average results of these estimates are presented in Table 10.

Table 10. Parking, Traffic, and Delay Index by Area

AREA	PARKING	TRAFFIC	DELAY ESTIMATE
SRES	2.7	1.7	1.9
MRES	3.3	2.0	3.0
DTWN	4.0	4.0	4.0

This data indicates that in the DTWN area collection activities are significantly affected by delays over which the crew has no control. Figure 16 illustrates the conditions of maximum delay. Significant delays will also occur to a lesser extent in the multi-unit residential areas. Minimum delay is encountered in the single unit residential areas, as illustrated by Figure 17.

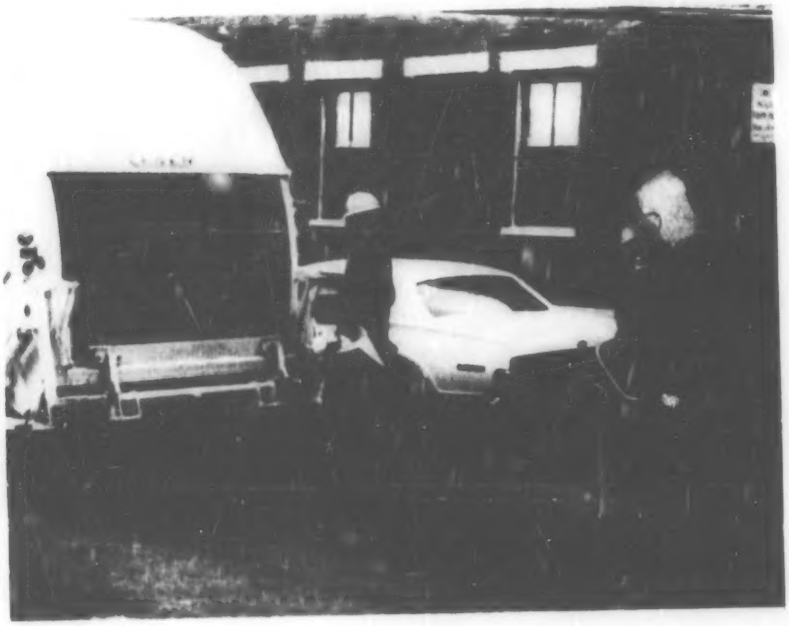


Figure 15. Downtown

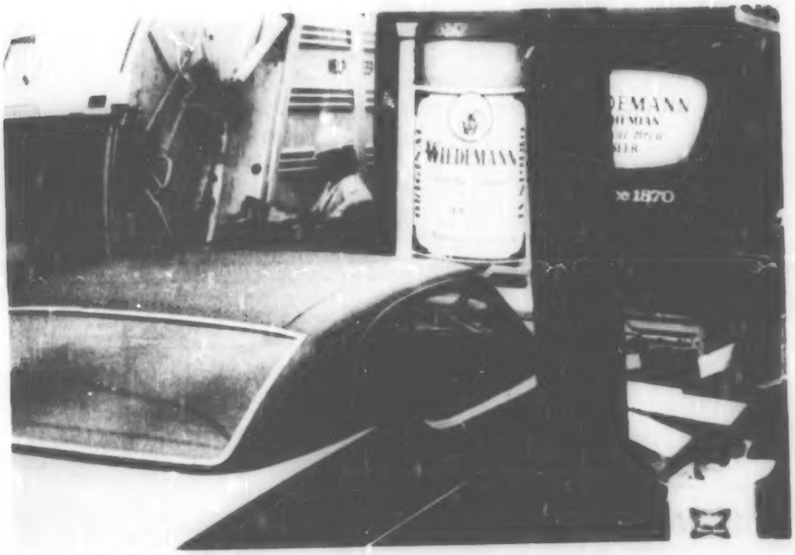


Figure 16. Maximum Delay Conditions

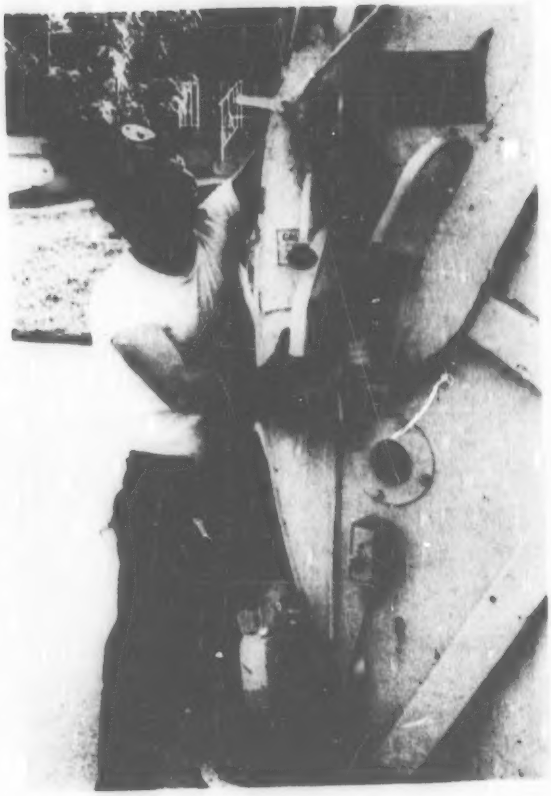


Figure 17. Minimum Delay Conditions

Approximately 3000 work sampling observations were recorded over a 10-week period. These observations were grouped by activity, using the codes in Table 11.

Table 11. Waste Collection Activity Codes

Activity	Code
not available for recording	NA
emptying cans	ECC
emptying bags	ECB
emptying equivalent cans	ECE
walking with full cans	WCC
walking with full bags	WCB
walking with equivalent cans	WCE
walking with empty cans	WEC
walking without bags--same stop	WEB
walking without equivalent cans--same stop	WEE
walk to next stop	WK
ride to next stop	RD
compacting	PK
site preparation	SP
truck backing	BK
litter pickup	LT
break	BRK

The following Tables summarize the data gathered in the study. Table 12 outlines the functional breakdown, as a percentage of crewmen's total work activity based on the total data (column 2), and according to the three previously mentioned areas types (columns 3-5). Percentages were calculated by dividing the number of specific activity observations by the total number of observations, and multiplying by 100 (reference computer program, Appendix 9.6). Table 13 lists percentage of occurrence adjusted to remove the effects of unrecorded observations (those noted as NA--not available). The adjusted data will be used in later analysis.

The work sampling activities were grouped into the following three classifications:

1) Activities that are productive work, that is, a direct part of the collection process of loading the waste into the truck.

2) Activities that are supportive productive work. These are indirect activities including delays that are largely dependent on the physical environment in which the operations are taking place.

3) Those activities that are non-productive and not part of the solid waste collection process (i.e., personal breaks). These are controllable directly by the crew.

Table 12. Original Field Data Summary

	PERCENTAGE OF OCCURRENCE			
ACTIVITY CODE	AVERAGE FOR ALL THREE AREAS	SRES SINGLE RESIDENCE	MRES MULTI RESIDENCE	DTWN DOWNTOWN
NA	2.980	3.120	3.286	2.465
ECC	13.686	12.132	17.841	13.732
ECB	2.235	2.253	3.286	1.480
ECE	3.817	1.733	4.695	7.394
WCC	6.425	5.546	7.042	7.746
WCB	3.911	4.506	5.164	1.761
WCE	2.328	1.560	1.878	4.225
WEC	4.935	6.239	1.878	4.577
WEB	0.559	0.347	0.000	1.408
WEE	0.186	0.173	0.000	0.352
WK	18.249	21.317	12.208	16.549
RD	12.663	13.345	7.981	14.789
PK	10.335	12.305	6.103	9.507
SP	8.845	10.572	6.573	7.042
BK	1.862	1.906	2.817	1.056
LT	0.838	0.693	0.939	1.056
BRK	6.145	2.253	18.312	4.930

Table 13. Adjusted Field Data Summary

	PERCENTAGE OF OCCURRENCE			
ACTIVITY CODE	AVERAGE FOR ALL THREE AREAS	SRES SINGLE RESIDENCE	MRES MULTI RESIDENCE	DTWN DOWNTOWN
ECC	14.09	12.52	18.41	14.08
ECB	2.29	2.32	3.39	1.44
ECE	3.91	1.79	4.85	7.58
WCC	6.59	5.72	7.25	7.94
WCB	4.01	4.65	5.33	1.82
WCE	2.39	1.61	1.94	4.33
WEC	5.06	6.43	1.94	4.69
WEB	0.57	0.36	0.00	1.45
WEE	0.19	0.18	0.00	0.36
WK	18.71	21.99	12.64	16.97
RD	12.98	13.76	8.27	15.16
PK	10.60	12.69	6.32	9.75
SP	9.07	10.90	6.81	7.22
BK	1.91	1.97	2.92	1.08
LT	0.86	0.71	0.97	1.08
BRK	6.33	2.32	18.97	5.05

The first classification, productive work, is comprised of the following:

1) Emptying of waste containers	ECC ECB ECE
2) Carrying full containers to truck	WCC WCB WCE
3) Returning emptied containers or walking to get others at same stop	WEC WEB WEE

The supportive productive category is comprised of the following:

1) To next stop	SK RD
2) Compacting and truck position	PK BK
3) At curbside or street	SP LT

The non-productive activity is personal time, BRK.

Table 14 below presents frequency of occurrence for each work classification by area.

Table 14. Work Classification, Frequency of Occurrence

WORK CLASSIFICATION	AVERAGE(%)	SRES(%)	MRES(%)	DTWN(%)
Productive work	39.08	35.58	43.29	43.68
Supportive productive work	54.13	62.02	37.93	51.26
Worker controlled breaks	6.33	2.32	18.97	5.05

These results show that in all areas significantly less than one-half of the workers' time is spent in direct productive work (loading solid waste). In the SRES area, nearly two-thirds of the time is spent in supportive productive activities of the job.

The maximum break time, 18.97 percent, was observed in the MERS area.

The following major conclusions regarding work sampling are offered:

1) Work sampling is a useful technique for analyzing waste collection work activities. The method is valuable for determining the percentage of time required for productive and supportive work, and non-productive activities.

2) Over one-half of the waste collection work day in the field (excluding disposal time) is consumed in supportive activities. These activities include unavoidable delays which are beyond the control of the worker. An example of an unavoidable equipment delay is compacting, which requires over 10 percent of the collection time.

SOLID WASTE COLLECTION STANDARDS DEVELOPMENT

The results of work measurement permit the establishment of work standards, that is, standard times that accurately reflect a normal work rate for an average worker. The work measurement techniques utilized in this study include work sampling as explained in the last Subsection, observation time study, and MTM.

Field Observations

Field observations were completed for the following major areas:

1) Stop-by-stop street and containerization data.

2) Intersection-to-intersection times.

3) Elemental times, e.g., walk, compact, delays.

4) Crew walk patterns during pickup.

5) Truck velocities between stops.

Stop-by-stop data: Detailed stop-by-stop data was recorded by field survey teams that accompanied the waste collection crews as they collected all existing routes. Nearly all loads from surveyed routes were weighed before disposal at the landfill. All of the information was coded and stored in files on either magnetic tape for batch processing or on disks for real-time on-line computer retrieval (reference Section 6).

Intersection Times: In addition to stop-by-stop data obtained for the entire City of Covington, total collection times were recorded for 1442 blocks. These data blocks with field times were utilized to create a separate data file, readily sortable and accessible by any one or combination of data parameters, e.g., street width, or stop distance. Table 15 summarizes the containerization and distance data for the blocks according to seven arbitrary collection categories.

While the data blocks with field times were available for a multiple linear regression analysis, the results were tempered with judgement based on the work measurement analysis. For example, regression analysis yields the following time equation from the data for double-sided collection, street width greater than three cars, stop distance greater than 100 feet (sample size = 65):

$$T = .206 + .0439(B) + .0783(C) + .2110(EC) + .00281(D)$$

where:

T = Block collection time in minutes
B = Number of bags
C = Number of cans
EC = Number of equivalent cans
D = Distance in feet between intersections

The constants are of the correct magnititudes and the resulting coefficient of correlation R is a reasonable .864. However, for other categories, e.g., double-sided, width less than 4 cars, stop distance less than 100 feet, the constants resulting from linear regression analysis are unreasonable and in some cases, negative, while R values are between .5 to .6. This clearly indicates that regression analysis alone is inadequate for establishing the linear constants for the collection time equation, and that work measurement analysis must be completed.

Elemental Times: While intersection-to-intersection times are useful for confirming calculated time standards applied to a given block, intersection times alone are inadequate for setting standards. Instead, work measurement must be applied to all elements of the collection operation, e.g., travel between stops, time to pick up containers from curbside, transport to truck, compact time. Results from the field indicate that unobstructed walk velocities are near MTM normal time (5.3 TMU's/foot or 5.2 feet/second), both with and without containers. Once the loading hopper is filled, 25 to 30 seconds are required for most trucks to compact. While some simultaneous activity may occur during compaction (preparation to dump, some dumping, return of empties), the majority of the time is an unavoidable delay. Since 8 to 10 cans will fill the hopper, the compaction

Table 15. SUMMARY OF HISTORICAL FIELD AND TIME DATA FOR 1442 BLOCKS

CATEGORY	SAMPLE SIZE	TIME, min.		BAGS (L)		CANS (L)		EQ.C. (L)		BAGS (R)		CANS (R)		EQ.C. (R)		DISTANCE, feet		STOPS	AVG. STOP DIST., ft
		$\bar{x}$	σ	$\bar{x}$	σ	$\bar{x}$	σ	$\bar{x}$	σ	$\bar{x}$	σ	$\bar{x}$	σ	$\bar{x}$	σ	$\bar{x}$	σ	$\bar{x}$	$\bar{x}$
SS < 100ft	205	3.780	2.41							5.75	5.84	11.77	7.70	3.63	6.26	368	178	5.68	68
SS >100ft	164	2.732	2.11							2.81	3.48	6.03	5.54	2.32	4.83	399	266	2.35	198
SS combined	369	3.314	2.34							4.44	5.14	9.22	7.39	3.05	5.70	382	222	4.20	126
≤3cans DS ≤100ft	635	5.378	3.72	4.39	5.3	11.40	36.2	2.53	20.2	5.01	15.1	10.53	17.9	1.78	3.34	385	188	7.2	58
> 3cans DS ≤100ft	228	4.373	2.73	3.68	4.2	7.88	5.8	2.11	3.7	3.33	4.4	7.62	6.2	1.60	3.0	339	134	5.8	64
≤3cans DS >100ft	145	2.855	2.54	2.04	2.7	4.26	4.1	.98	2.11	1.35	3.36	2.72	3.67	.91	4.3	387	252	2.5	172
>3cans DS >100ft	65	2.846	2.53	3.31	6.8	5.11	4.9	2.51	5.4	1.06	2.7	2.11	3.57	1.09	3.7	400	254	2.4	197

SS:	Single-Sided Collection	(L):	Left Side of Street
DS:	Double-Sided Collection	(R):	Right Side of Street
$\bar{x}$:	Arithmatic Mean		
σ:	Estimated Standard Deviation		

delay time prorated on an individual can basis may be as high as 4 seconds.

Other unavoidable delays form an important segment of the total collection time and vary considerably throughout the city. Included are delays due to street and pedestrian traffic, clean up at setout site and rear of truck, parking congestion and traffic lights. As discussed in the last section, work sampling techniques were used to estimate delay times and causes.

Crew Walk Patterns During Pickup: A complexity inherent in setting standards for multi-man crews arises from the variations in crew walk patterns. Although the interaction patterns among the two workers and the truck are somewhat different for each crew, certain patterns predominate. Field observations were used to establish crew and truck patterns. The major categories observed were:

1) Single-sided collection with no curbside parking (therefore truck approaches curb).

2) Single-sided collection with parking, thereby requiring manual transport of containers to and from truck.

3) Double-sided collection without right curb parking.

4) Double-sided collection with right curb parking.

For stops that are closely spaced, the workers will walk between stops, while for interstop distances greater than a certain critical distance, time is saved by riding the truck. This cross-over distance, which is clearly a function of truck velocity, walk speed, and walk patterns, is examined in more detail later in this Subsection.

Truck Velocities Between Stops: The truck used in the velocity analysis was a standard eighteen cubic yard rear load packer truck supplied by the City of Covington, and was three-fourths filled. Truck velocities were measured over distances of 50 to 200 feet at 50 feet intervals as shown in Figures 18 and 19. On the basis of these measurements, average velocities for each of the distances were then computed and are graphically depicted in Figure 20.

Laboratory

On the basis of field observations, the manual process of collecting solid waste was divided into the following seven elements for laboratory simulation:

1) Walk from truck to container set-out location.

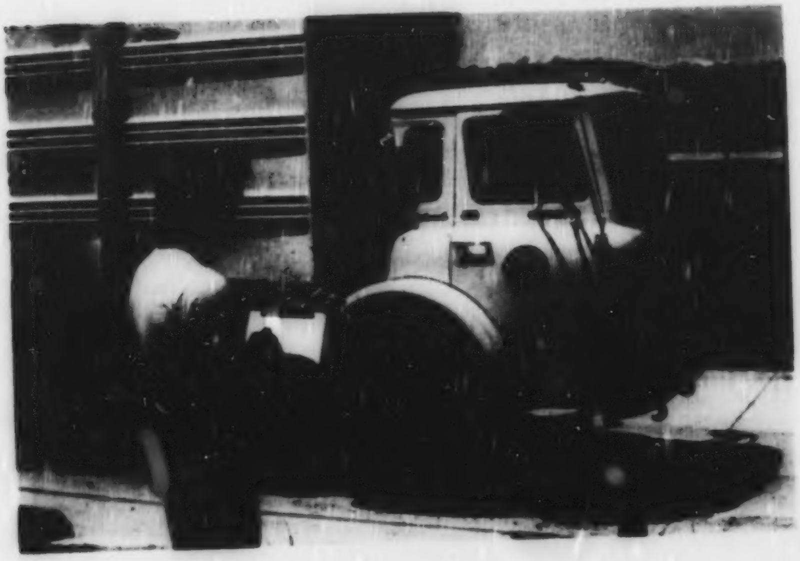


Figure 18. Field Measurement of Truck Velocity, Level Terrain

Figure 19. Field Measurement of Truck Velocity, Incline

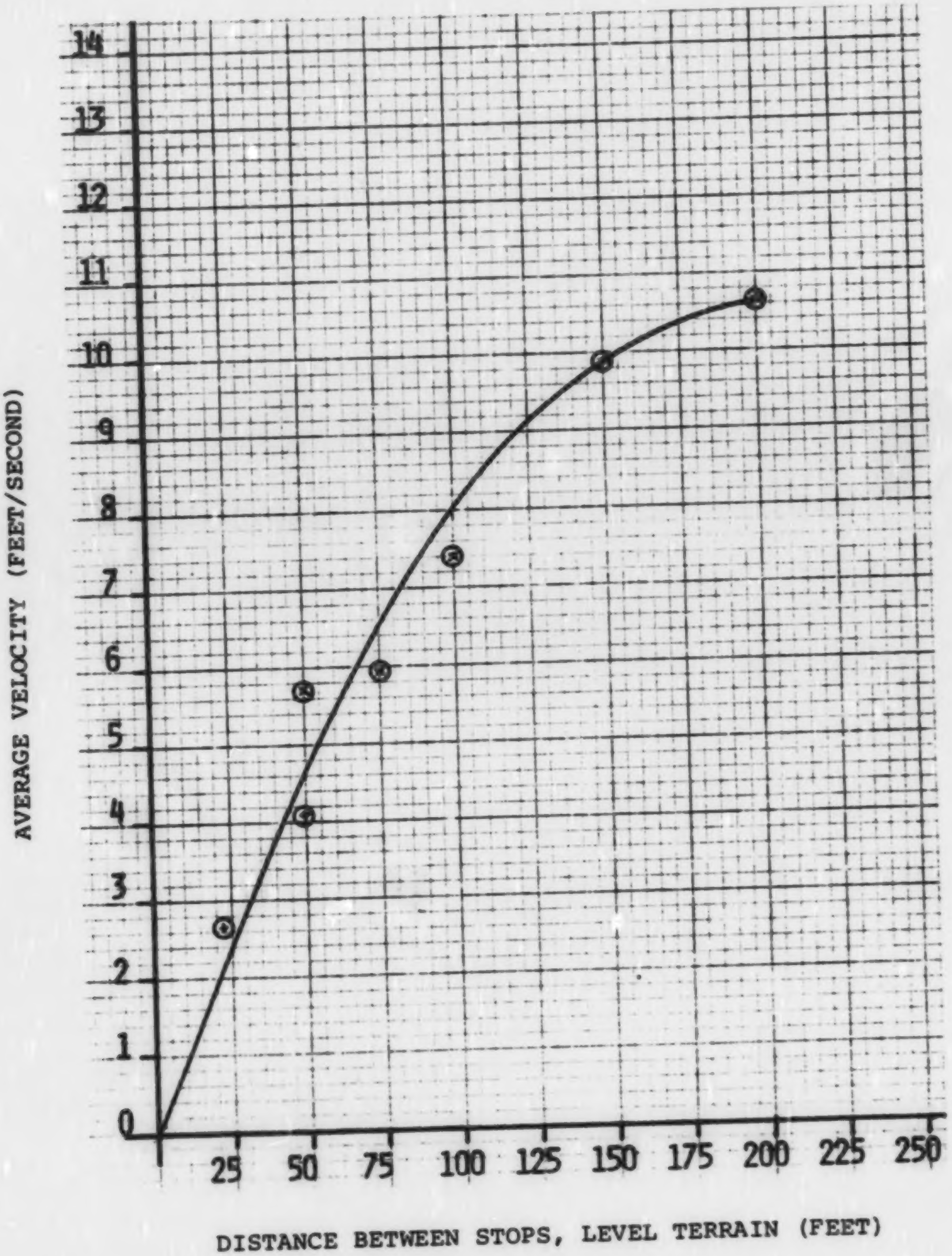


Figure 20. Average Truck Velocity

2) Grasp and pickup full container(s).

3) Walk to truck with full container(s).

4) Dump container(s).

5) Walk back to container storage location with empty container(s).

6) Place empty container(s) on the ground.

7) Walk back to truck.

A typical two-lane city street, as shown in Figure 21, was simulated in the laboratory. The collection truck was placed in a lane so that the walking distance from the truck to the storage locations on each side of the street were twelve and nineteen feet, respectively.

Each of the above seven elements of the collection process were then stopwatch timed over a number of trials. The resulting total times were leveled over a number of trials and a normal time for each step in the process was determined. This process was repeated with variations in the number and type of containers picked up, and varied for the twelve and nineteen feet distances. The normal times for each of the steps were then added together to determine the total normal time required for pickup of a given number of containers from one or both sides of the street by one and two laborers. As an example of the results, the time data for collection of cans from one side of the street is shown in Figure 22.

On the basis of manual collection and truck movement times, collection times were computed for crews riding the truck between collection stops. The results are shown in Table 16. Adjusting the normal walking velocity (MTM) for angle movement, the average forward walking velocity between stops was three feet per second. The resulting total collection times as computed for crews walking are shown in Table 17. These results permit crossover points to be determined as illustrated in Figure 23. This Figure represents the total time for one-sided collection by one worker. N is the number of cans. T_w is walking time, T_r is the riding time. The theoretical walk/ride crossover point appears to be at some distance greater than 50 feet, that is, the crew should walk between stops spaced less than 50 feet apart.

Summary and Conclusions

On the basis of the field observations and laboratory simulations, time predictive equations have been developed for major collection categories, e.g., single-sided collection with average stop spacing greater than 100 feet. The collection time required

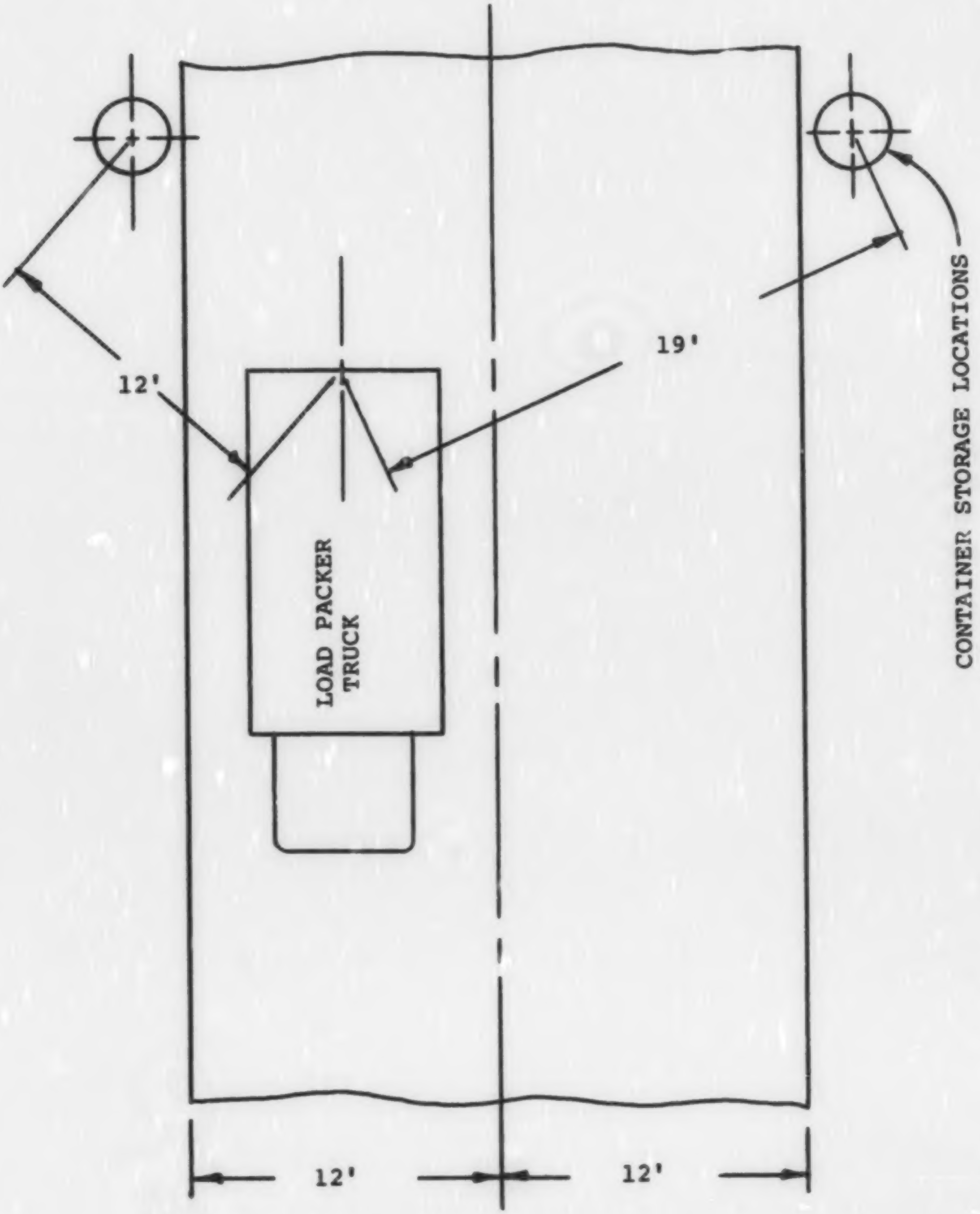

12'
19'
CONTAINER STORAGE LOCATIONS
LOAD PACKER TRUCK
12'
12'

Figure 21. Laboratory Collection Model

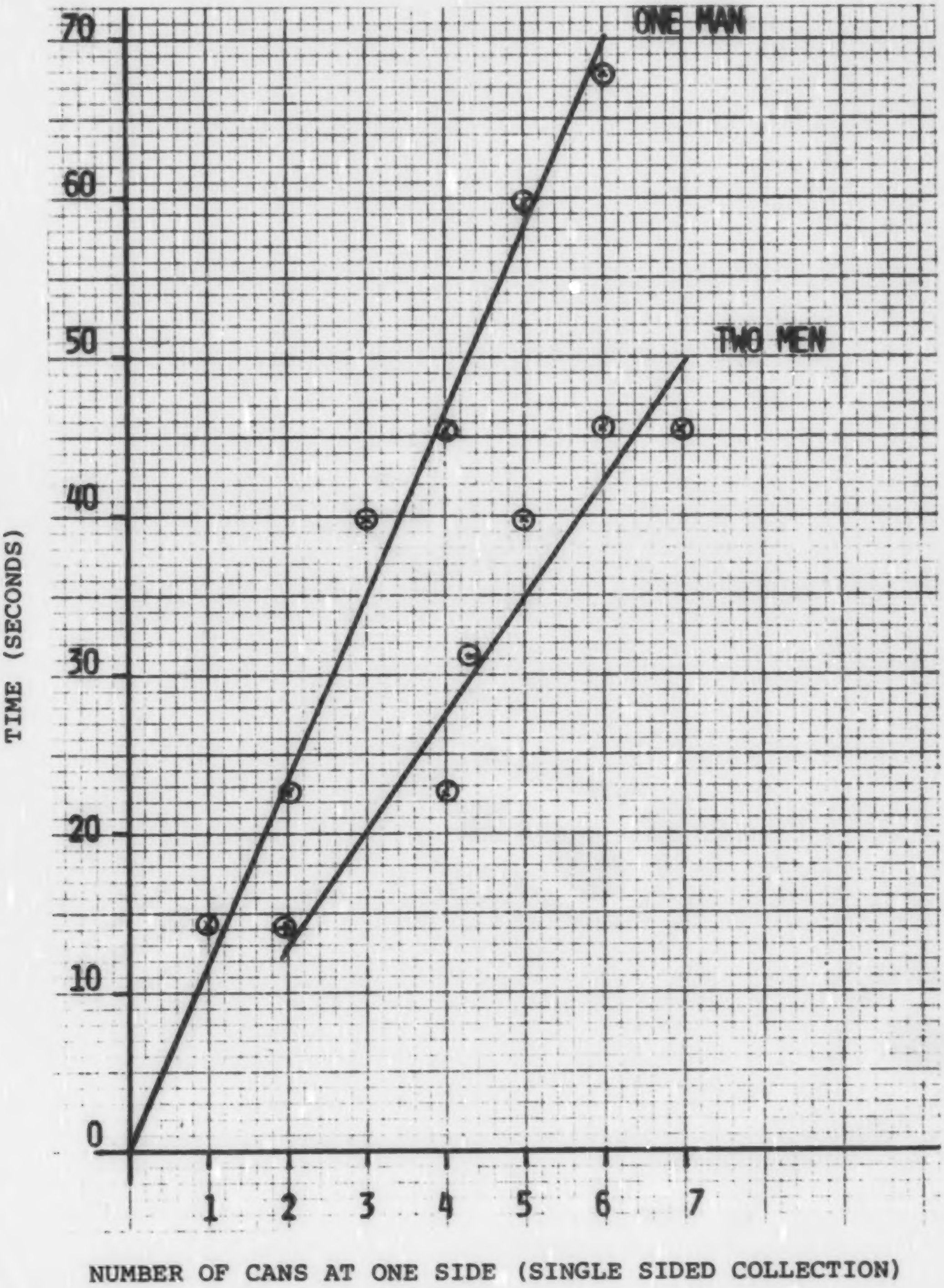


Figure 22. Manual Collection Times

Table 16. COLLECTION TIMES, RIDING*

	1				2				3				4			
N	DSTP	VTRK	RD	Tr	DSTP	VTRK	RD	Tr	DSTP	VTRK	RD	Tr	DSTP	VTRK	RD	Tr
1	0	0	0	18.26	15	1.4	10.7	28.96	30	2.80	10.7	28.96	60	5.4	11.1	29.36
2	0	0	0	26.68	15	1.4	10.7	37.38	30	2.80	10.7	37.38	60	5.4	11.1	37.78
3	0	0	0	44.94	15	1.4	10.7	55.64	30	2.80	10.7	55.64	60	5.4	11.1	56.04
4	0	0	0	53.36	15	1.4	10.7	64.06	30	2.80	10.7	64.06	60	5.4	11.1	64.46
5	0	0	0	71.62	15	1.4	10.7	82.32	30	2.80	10.7	82.32	60	5.4	11.1	82.73
6	0	0	0	80.04	15	1.4	10.7	90.74	30	2.80	10.7	90.74	60	5.4	11.1	91.14

	5				6				7			
N	DSTP	VTRK	RD	Tr	DSTP	VTRK	RD	Tr	DSTP	VTRK	RD	Tr
1	100	7.4	13.5	31.76	150	9.9	15.2	33.46	200	10.65	18.8	37.06
2	100	7.4	13.5	40.18	150	9.9	15.2	41.88	200	10.65	18.8	45.48
3	100	7.4	13.5	58.44	150	9.9	15.2	60.14	200	10.65	18.8	63.74
4	100	7.4	13.5	66.86	150	9.9	15.2	68.56	200	10.65	18.8	72.16
5	100	7.4	13.5	85.12	150	9.9	15.2	86.82	200	10.65	18.8	90.42
6	100	7.4	13.5	93.54	150	9.9	15.2	95.24	200	10.65	18.8	98.84

*Cans only for single sided collection by one man riding to next stop.

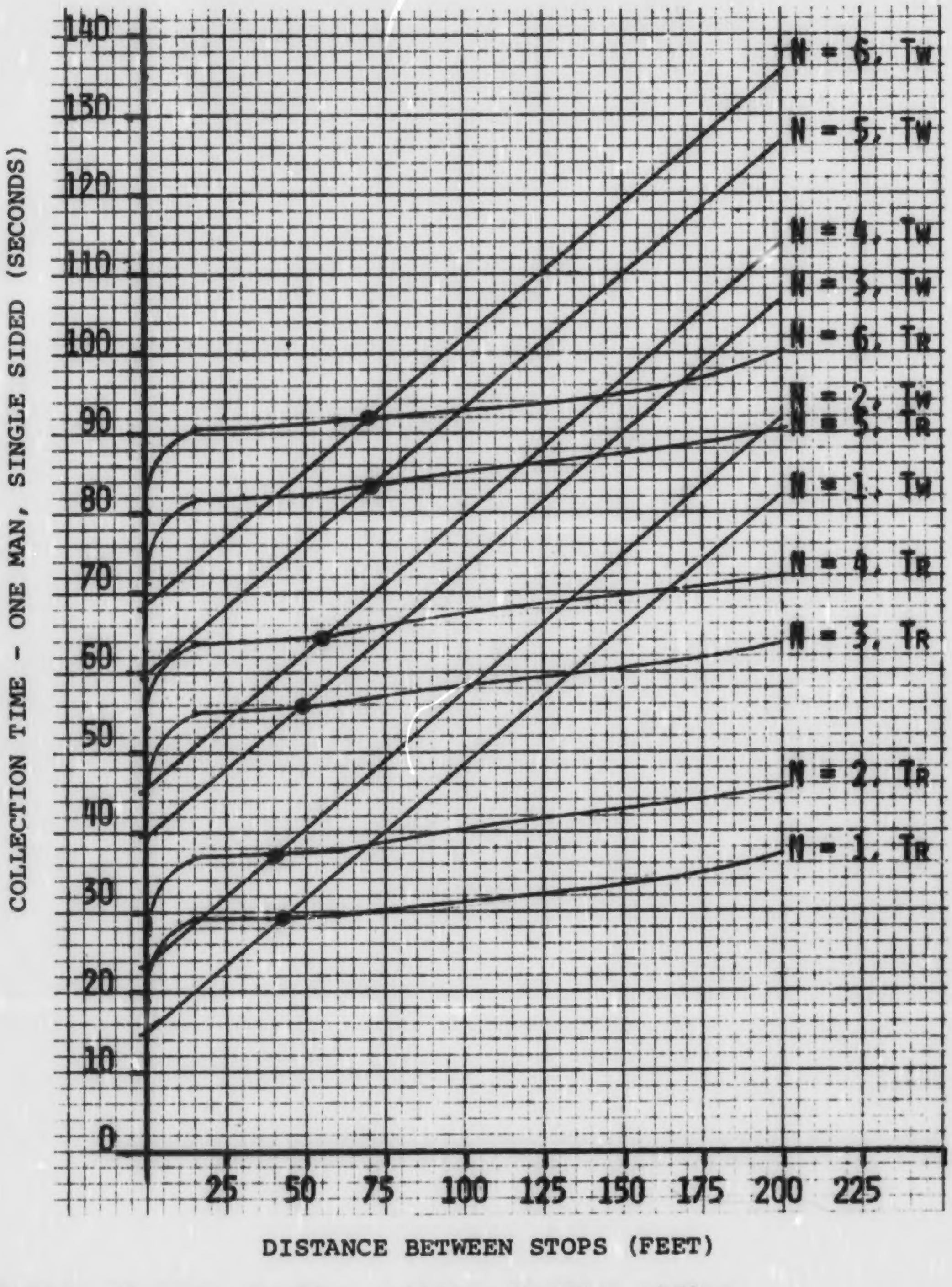
N = No. of cans
DSTP = Distance to next stop in feet
VTRK = Average velocity of truck in feet/sec.
RD = DSTP/VTRK in seconds
Tr = Total collection time in seconds

Table 17. COLLECTION TIMES, WALKING*

N	DSTP	WLK	TW	DSTP	WLK	TW	DSTP	WLK	TW	DSTP	WLK	TW	DSTP	WLK	TW
1	0	0	14.26	15	5	19.26	30	10	24.26	60	20	34.26	120	40	54.26
2	0	0	22.65	15	5	27.65	30	10	32.65	60	20	42.65	120	40	62.65
3	0	0	39.91	15	5	44.91	30	10	49.91	60	20	59.91	120	40	79.91
4	0	0	45.30	15	5	50.30	30	10	55.30	60	20	65.30	120	40	85.30
5	0	0	59.56	15	5	64.56	30	10	69.56	60	20	79.56	120	40	99.56
6	0	0	67.95	15	5	72.95	30	10	77.95	60	20	87.95	120	40	107.95

*Cans only for single sided collection by one man walking to next stop.

VMAN = Forward Velocity of Collector = 3 ft/sec
N = No. of cans
DSTP = Distance to next stop in feet
WLK = DSTP/VMAN in seconds
TW = Total collection time in seconds



N=Number of cans, T_W=Time walking, T_R=Time riding

Figure 23. Walk/Ride Crossover Points

for a given block face is predicted by inputing into the appropriate equation containerization counts and street lengths for the block. These results were utilized in Section 7 for waste collection route development in the test City.

It is concluded that management's ability to estimate work time is essential if it is to:

1) Provide equitable, balanced work assignments, thereby controlling overtime and minimizing interpersonnel and union/management conflicts.

2) Monitor on a continuing basis the productivity of various components of the existing collection/disposal system.

3) Respond to changing geographical waste generation patterns resulting from new construction, abandonment and demolition, annexation, and other shifts in land use.

4) Project the impact of possible changes in service level such as changes in collection frequency, setout service, or containerization, e.g., cans to bags.

5) Evaluate new equipment available on the market such as higher density load packers, or one-worker sideloaders.

6) Plan for major changes in collection constraints, e.g., changes in disposal sites or crew size.

7) Implement a monetary incentive program to encourage higher productivity by sharing savings with personnel.

FOOTNOTES

[1] Shell, R. L., and Shupe, D. S., "Work Standards for Waste Collection," Proceedings, Annual Systems Conference, American Institute of Industrial Engineers, 1973.

[2] Quon, J. E., Charnes, A., and Wersan, S.J., "Simulation and Analysis of a Refuse Collection System," Journal of the Sanitary Engineering Division, American Society of Civil Engineers, Vol. 91, No. SA5, October 1965.

[3] Truitt, M. M., Liebmann, J. C., and Kruse, C. W., "Simulation Model of Urban Refuse Collection," Journal of the Sanitary Engineering Division, American Society of Civil Engineers, Vol. 93, No. SA2, April 1969.

[4] Truitt, M. M., Liebmann, J. C., and Kruse, C. W., Mathematical Modeling of Solid Waste Collection Policies, Volumes 1 and 2, USPHS Publication 2030, 1970.

[5] Bubier, R. H., "Modern Refuse Vehicle Routing," Public Management, August 1973.

[6] Shupe, D. S., and R. L. Shell, "Balancing Waste Collection Routes," Journal of Environmental Systems, Vol. 1, No. 4, December 1971.

[7] Clark, R. M., and Gillean, J. L., Systems Simulation and Solid Waste Planning: A Case Study, Report 67015-73-12, National Environmental Research Center, USEPA, 1973.

[8] Wyskida, R. M., and Gupta, J. N. D., "IE's Improve Cities Solid Waste Collection," Industrial Engineering, Vol. 4, No. 6, June 1972.

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[10] Stone, R. and Company,Inc., A Study of Solid Waste Collection Systems Comparing One-Man with Multi-Man Crews, USPHS Publication 1892, 1969.

[11] Employee Incentives To Improve State and Local Government Productivity, National Commission on Productivity and Work Quality, Pub. No. CP75015, Washington, D.C., 1975.

[12] Shell, R. L., and D. S. Shupe, "Predicting Work Content for Residential Waste Collection," Industrial Engineering, Vol. 5, No. 2, February 1973.

[13] Shell, R. L., and D. S. Shupe, Pilot Research Project for the City of Cincinnati, Department of Public Works, Division of Waste Collection, University of Cincinnati, 1971.

[14] Fuertes, L. A., Hudson, J. F., and Marks, D. H., Analysis Model for Solid Waste Collection, Department of Civil Engineering, Massachusetts Institute of Technology, 1972.

6 COMPUTERIZED DATA BANK

INTRODUCTION

The data bank consists of several files containing solid waste information on every collection stop in Covington with physical and geographical characteristics of each block face.

The stop-by-stop data was obtained by field survey teams that accompanied the waste collection crews as they collected all existing routes (Street Collection Data Form, Appendix 9.3). A typical route trace pattern is shown below in Figure 24. Nearly all loads from surveyed routes were weighed by a local feed supply

Figure 24. Example Map of Stop-By-Stop Field Survey

company before disposal at the landfill (Weigh Station Record Form, Appendix 9.4).

All of the information was coded and stored in files on either computer magnetic tape for batch processing or on direct-access devices for real-time online computer retrieval.

This data base was created to provide detailed information about the test City that can be rapidly accessed, sorted, and used for computation and analysis. Since the information stored in the data bank was critical to all subsequent computations, it was essential that data errors be minimized. Therefore, all data transfer operations were verified during the data computerization.

The remainder of this Section describes the methodology used to develop the data bank, including the transfer of information from the field survey, and defines the data classification format.

Encoding

The first task following completion of the field survey forms was to determine how the information should be transferred onto a standard (80-column) IBM card. This was achieved by assigning codes for different segments of the information. There are over 700 streets in the City and each street was given a numerical code number for identification purposes (see Appendix 9.5). A separate file containing all street names with their identification codes was stored on magnetic tape.

The coding of the survey information required data classification as follows:

Summary Record: This record summarized the collection data for a given route on a given day. The Summary data contains the following specific information:

Date of the survey

Route number (existing)

Truck number

Time at the start of the day

Truck mileage at the start of the day

Number of trips to the landfill (loads)

Total number of bags collected

Total number of cans collected

Total number of equivalent cans collected

Header Record: During pickup, the path of a collection crew was recorded as a sequential series of approximately straight-line street segments, each identified (for example) as "on Pike from 8th to 12th." The header record contained physical and geographical data for a given street segment. The information coded on this record is:

Street segment identification (on____, from____, to____)

Street width

Parking, if any, on the left side of the street

Parking, if any, on the right side of the street

Load number

Time at the first stop in the pickup run

Stop Record: This record contained information on every collection stop with in the City. In general, there are several stops in each street segment and for each of these stops there was on record containing the information:

Stop number

Containerization, left side of street

1) Number of bags

2) Number of cans

3) Number of equivalent cans

Containerization, right side of street

1) Number of bags

2) Number of cans

3) Number of equivalent cans

Number of loadpacking cycles, if any

Delay from normal operation, if any

Those stops located near intersections within a street segment contain the following additional information:

Name of the street reached

Time at new street intersections

Distance travelled (in map inches)

All data was key punched on IBM cards and then copied on magnetic tape by using the IBM utility program IEBGENER.1* Information on tape permits ease in handling and provides efficient retrieval.

DESCRIPTION OF PROGRAMS

There were 14 major programs in the overall collection system. In this subsection, each major program is discussed.

Program 1, Survey Data Verification

This program used the coded survey data as input and then printed out a report for every route for each day in a tabular form with the coded information displayed in a systematic manner. This output was checked against the original survey data. Key punching errors were corrected and the survey file was modified by using the IBM Utilities Program IEBUPDTE.2 Finally, a second output report was compared with the original survey data to insure an error-free data file.

A block diagram of the Program to generate the report is given in Figure 25.

Program 2, Block Generation Program

This Program used the coded survey data and generated individual block data records for all routes in the City. The generated blocks were then stored on magnetic tape in the Block Data File.

This program divided the entire information of the survey into several smaller segments related to a block on a given street. Figure 26 shows the schematic diagram for the Program. In addition to other physical and geographical information, this data also included the length of the block and the field-recorded time for collection of particular blocks, which were used in the linear relationship development as previously outlined in Section 5.

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*References and footnotes at end of Section.

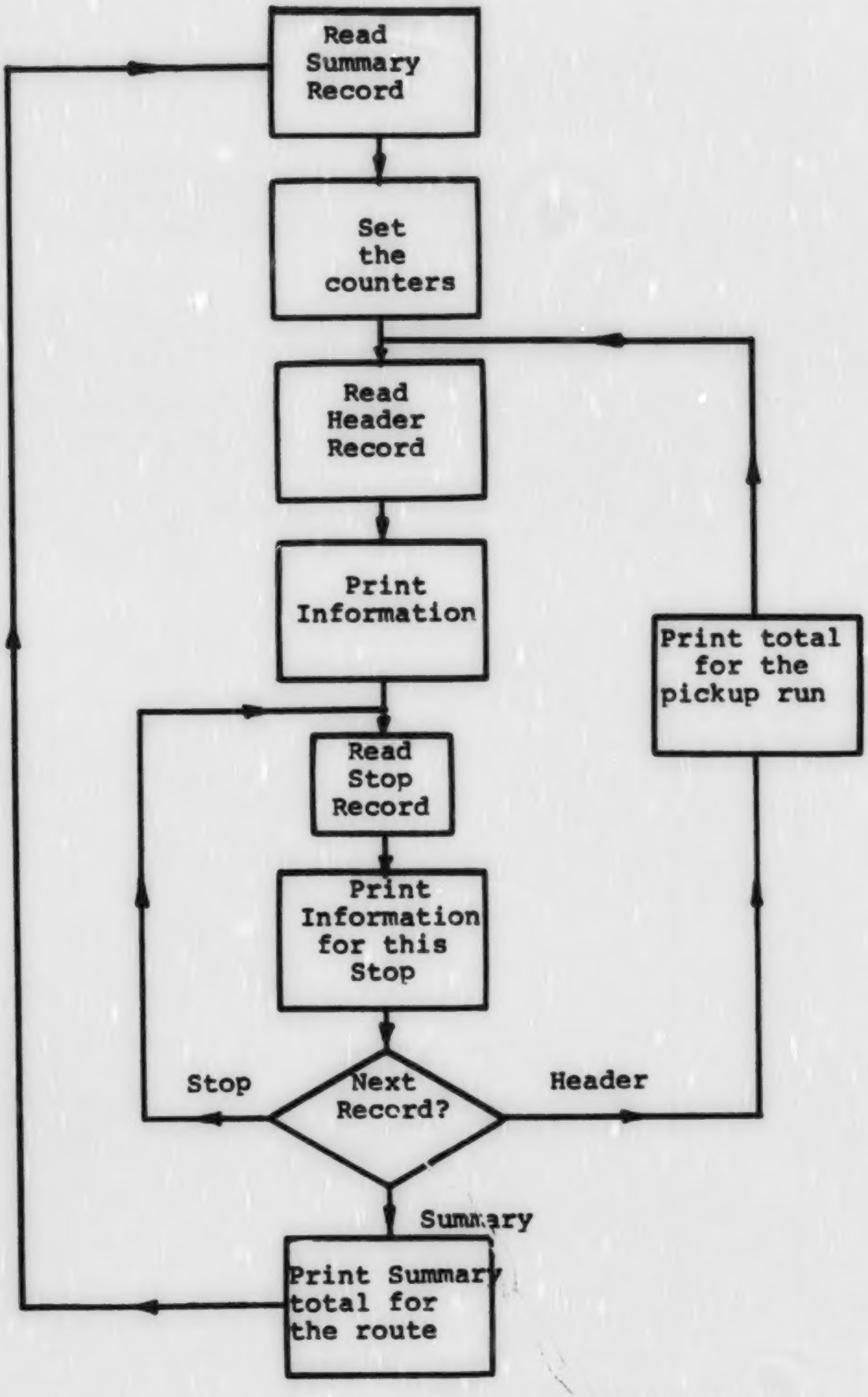

Read Summary Record
Set the counters
Read Header Record
Print Information
Read Stop Record
Print Information for this Stop
Next Record?
Stop
Header
Summary
Print total for the pickup run
Print Summary total for the route

Figure 25. Survey Data Verification

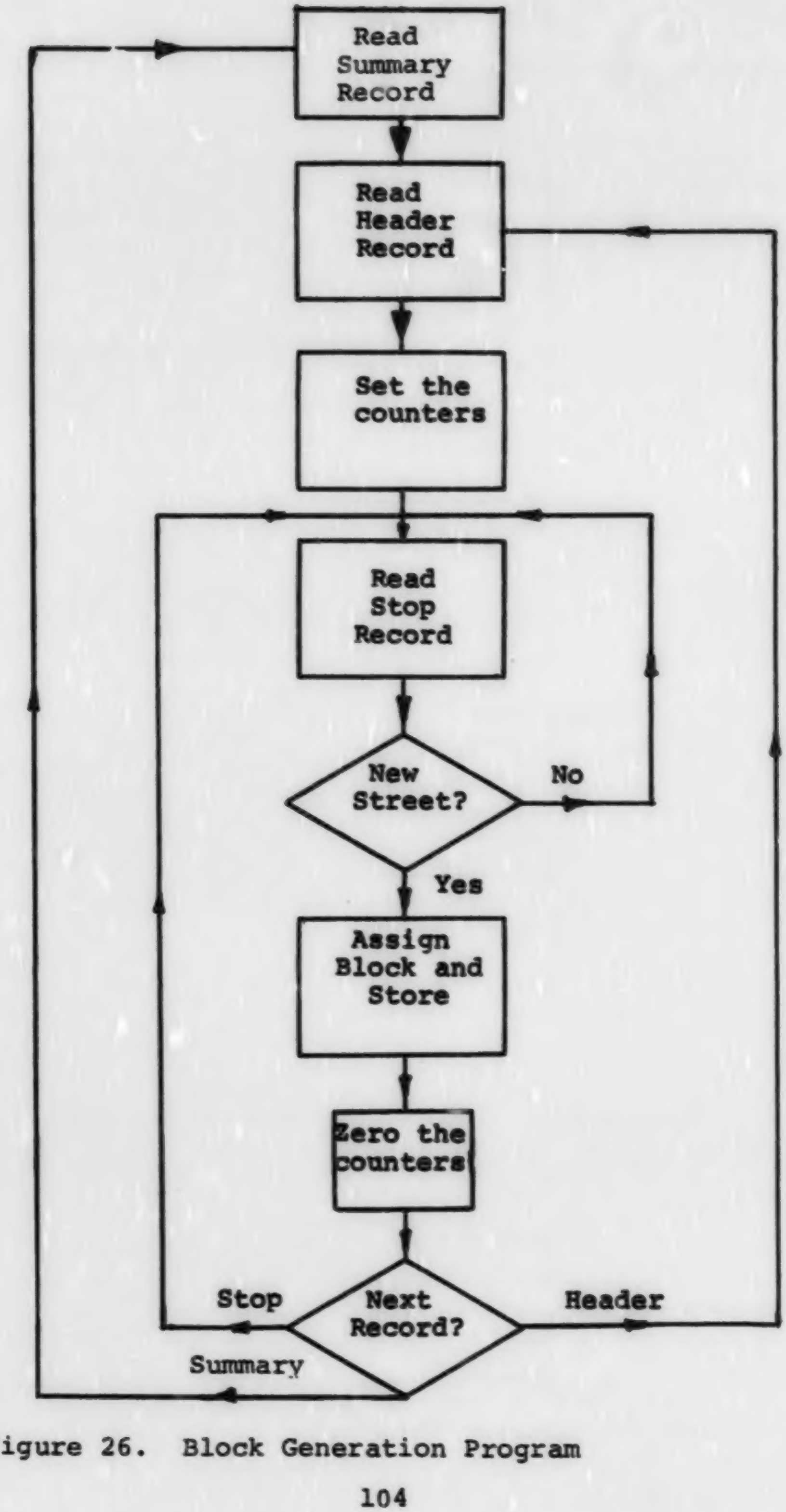

Read Summary Record
Read Header Record
Set the counters
Read Stop Record
New Street?
No
Yes
Assign Block and Store
Zero the counters
Next Record?
Stop
Header
Summary

Figure 26. Block Generation Program

Program 3, Block Data File Verification

To verify the Block Data File, a program was written which accepted the Block Data File as input and printed out a report in tabular format. This printed report was then compared with the original survey data, and all errors were modified by using the IBM utilities Program IEBUPDTE.[2]

The block diagram for this Program is given in Figure 27.

Program 4, Block Classification

One of the uses for the Block Data File was to have information on complete blocks for statistical analysis and development of time-predictive equations. To accomplish this, data was classified according to the following characteristics:

Single-sided collection

Double-sided collection

Average distance between stops

Width of the street for double-sided collection

Table 18 outlines the six groups of data available for analysis and equation development.

Table 18. Classification of Blocks

Group	Single or Double Sided Pickup	Average Distance Between Stops	Street Width for Double Sided Pickup
1	Single	$\leq$100 ft.	
2	Single	$\overline{>}$100 ft.	
3	Double	$\leq$100 ft.	$\leq$3 cars
4	Double	$\overline{\leq}$100 ft.	$\overline{>}$3 cars
5	Double	$\overline{>}$100 ft.	$\leq$3 cars
6	Double	>100 ft.	$\overline{>}$3 cars

The block diagram for this Program is shown in Figure 28, and the output was stored in file call Classified Blocks.

Program 5, Classified Block Sorting

The Classified Block Data File was sorted according to the various groups using the IBM SORT/MERGE Program.

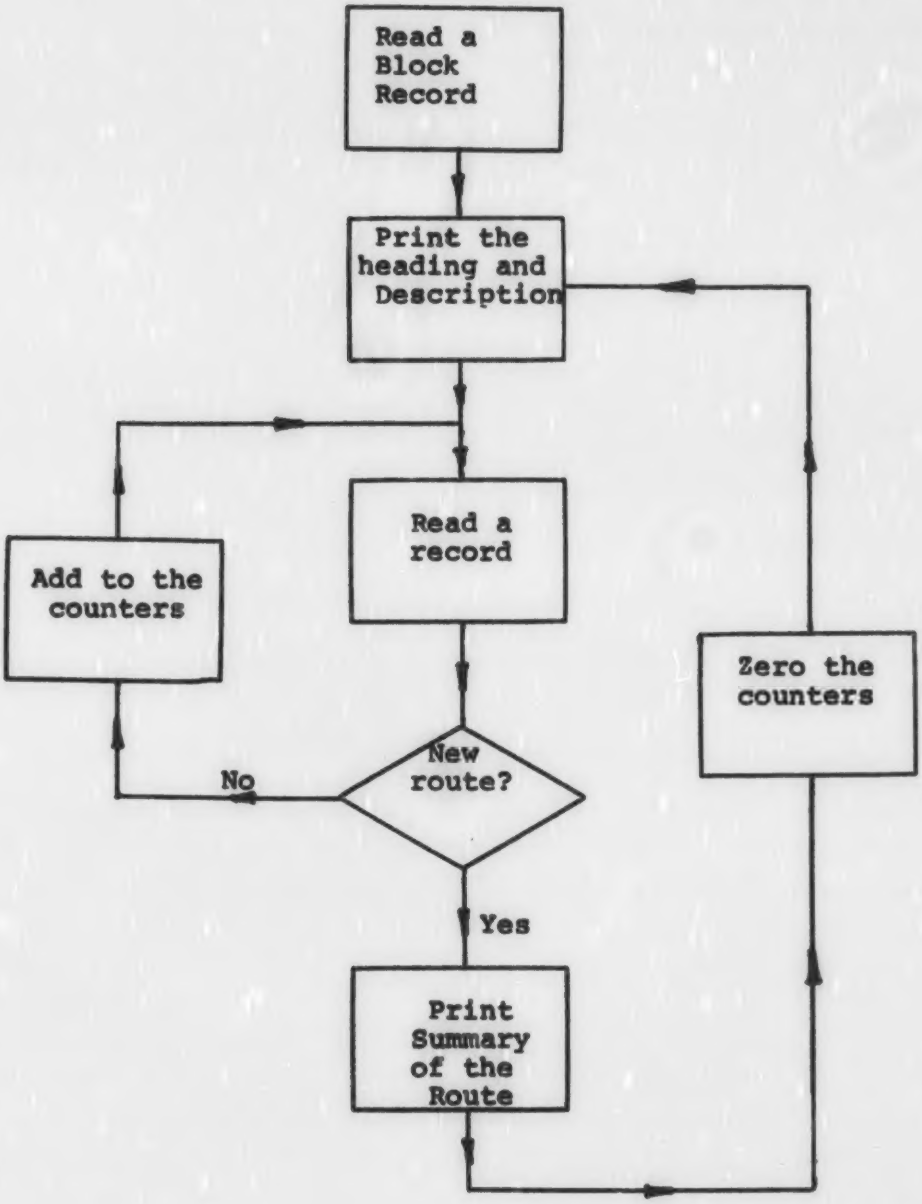

Read a Block Record
Print the heading and Description
Read a record
Add to the counters
New route?
No
Yes
Print Summary of the Route
Zero the counters

Figure 27. Block Data File Verification

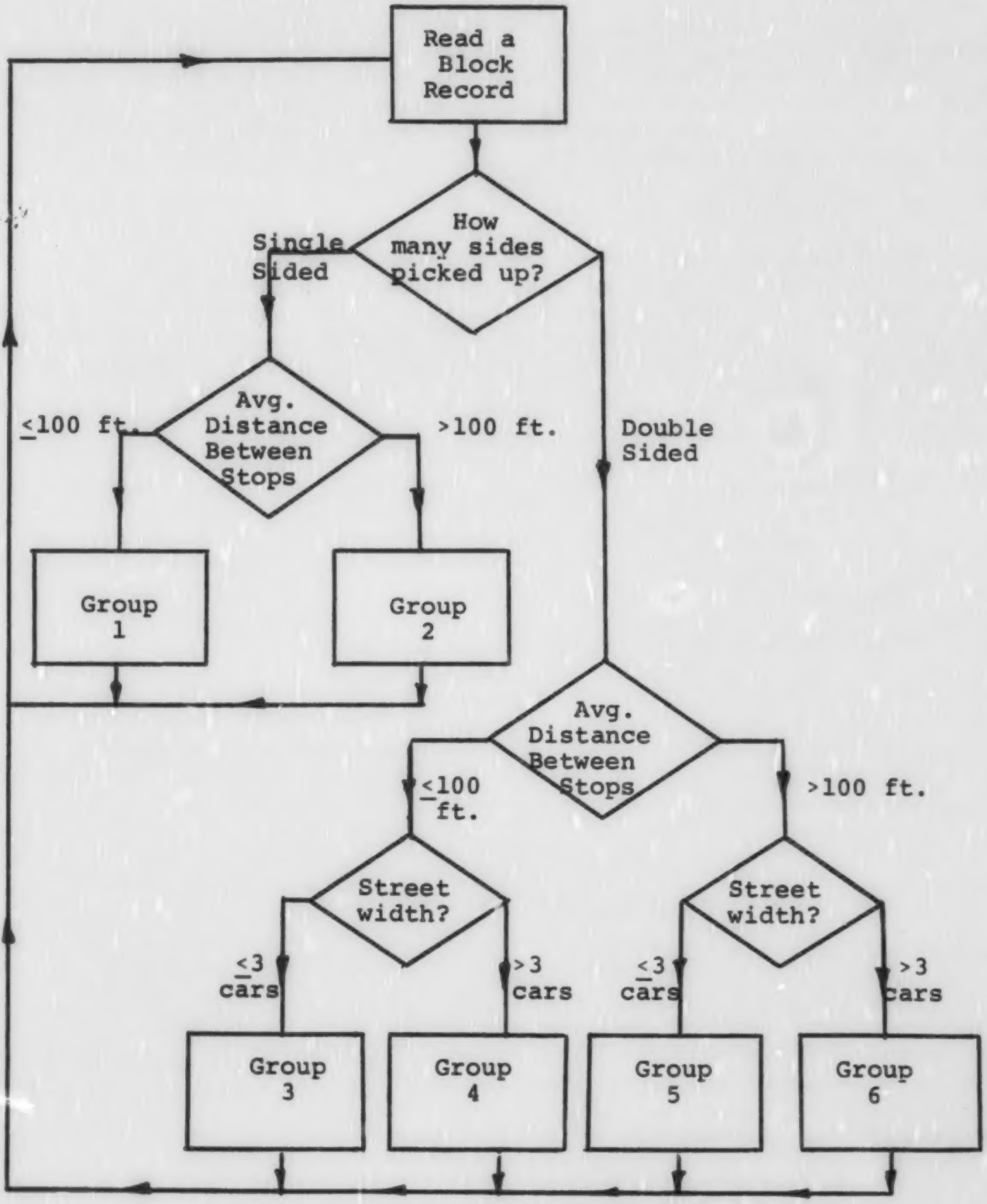

Read a Block Record
How many sides picked up?
Single Sided
Double Sided
Avg. Distance Between Stops
≤100 ft.
>100 ft.
Group 1
Group 2
Avg. Distance Between Stops
≤100 ft.
>100 ft.
Street width?
≤3 cars
>3 cars
Street width?
≤3 cars
>3 cars
Group 3
Group 4
Group 5
Group 6

Figure 28. Block Classification

Program 6, Regression Data

Field collection times were not recorded for all blocks. Therefore, for later use in developing time-predictive equations, a separate file was compiled from the total block file by selecting only those blocks with times recorded. The data was stored in a file called Regression Data. Figure 29 shows the block diagram of this Program.

Program 7, Regression Analysis

An extensive regression analysis was performed using the Regression Data as input to the BMD package program $BMDO3_R$.[4] This program performs regression analysis for multiple variables and has the option of combination. This was extremely helpful in the analysis of different classification groups. The following variables were used in the analysis:

Field recorded collection time

Length of block

Total number of bags collected

Total number of cans collected

Total number of equivalent cans collected

Total number of stops in the block

The transformed variables for the double-sided pickup were:

Total number of bags

Total number of cans

Total number of equivalent cans

Program 8, Sorting Block Data

This Program arranged the block file data according to route number, day of collection, and the specific load in the day. The output of the program was stored in Sorted Block File. Sorting was achieved by using the IBM SORT/MERGE Program.[3]

Program 9, Density Report

In order to predict the weight of the solid waste generated by stop, it was necessary to determine an average weight per container (bag or can). This was accomplished by averaging the net weight of each load over its container count. This Program used the Sorted Block File as input and computed average weights

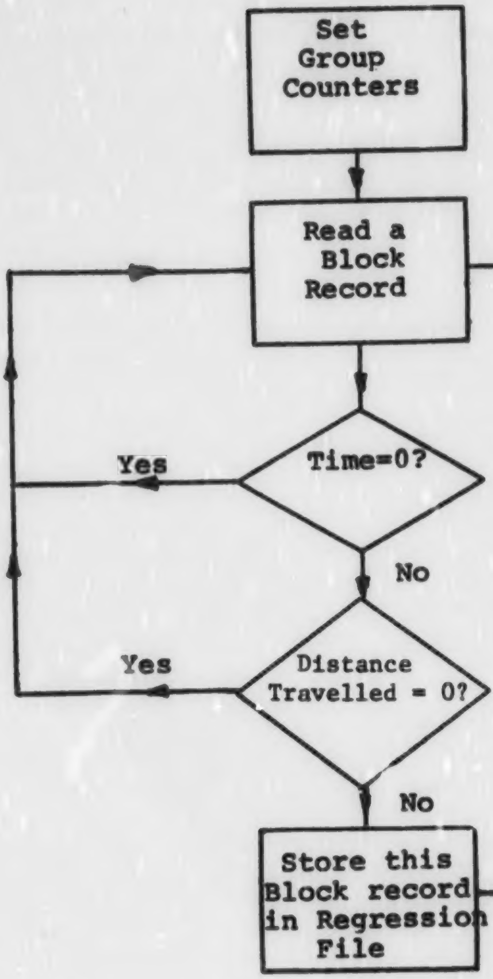

Set Group Counters
Read a Block Record
Time=0?
Yes
No
Distance Travelled = 0?
Yes
No
Store this Block record in Regression File
Update Group Counter

Figure 29. Regression Data

for each load by route and day, for the entire City.

The block diagram for this Program is given in Figure 30.

Program 10, Predictive Results

After calculating the waste densities by load and obtaining time-predictive linear equations through work measurement and regression analyses, the solid waste generation time for each block were computed by this program. The input for this program consisted of the Block Data File together with the time-predictive linear equations and the density calculations. The Program output printed the results in tabular form and also stored the output in the Prediction File. Figure 31 shows the block diagram for this program.

The predictions were compared with the field-recorded time and weight values. Since the predicted weights and times were to be utilized in on-line route development, they were filed by block number on disk storage.

Program 11, File Verification

In order to properly access the block time and weight data, it was necessary to identify the data blocks by map location. For this purpose, identification (ID) numbers were assigned to every block in the City (1 through 1210), using a large scale map (Appendix 9.5). The data block numbers were then identified by the appropriate ID numbers according to first or second collection. This file was stored on disk and called the ID File. Time and weight information for any street in the City was obtained by locating the street on the map and entering its ID number into the terminal.

Before designing the routes, it was considered appropriate to verify the ID File. For this purpose, a verification program was developed to automatically provide a printout for all the ID numbers in the City. The output was then verified and corrected. The block diagram of this Program is given in Figure 32.

Program 12, Route Design

After verifying all data and files, a program was written to design collection routes. One of the objectives in designing the routes was to provide for active involvement of Public Works personnel in the project. This suggested the development of a system simple to operate and requiring minimal training. Also, it was desirable to provide flexibility so that a route could easily be changed and the impact of such a change be known immediately. To accomplish this, an on-line terminal system was used to design the route area alternatives included later in Section 7. This system was programmed for conversational mode and required

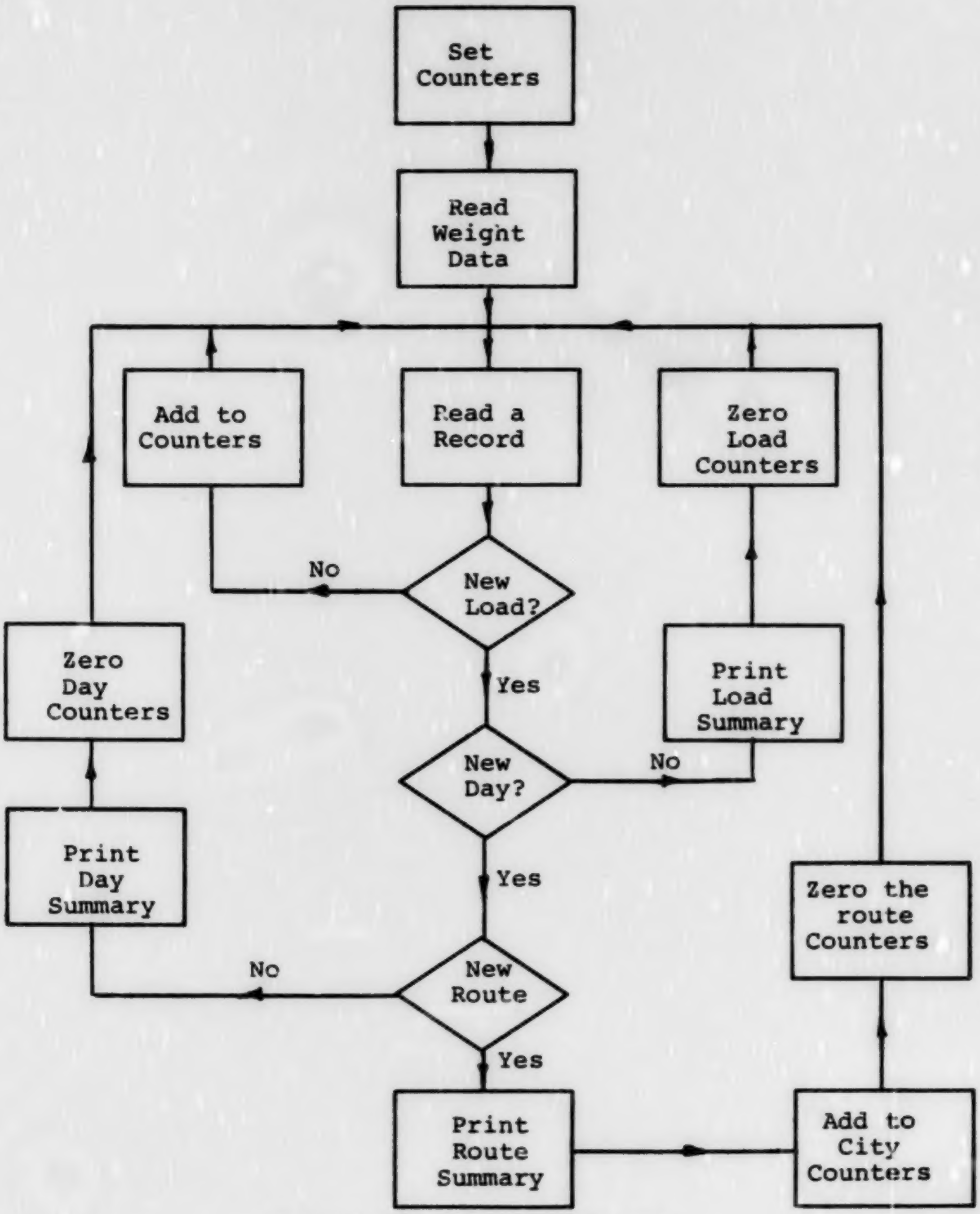

Set Counters
Read Weight Data
Add to Counters
Read a Record
Zero Load Counters
No
New Load?
Yes
Zero Day Counters
Print Load Summary
New Day?
No
Yes
Print Day Summary
Zero the route Counters
No
New Route
Yes
Print Route Summary
Add to City Counters

Figure 30. Density Report

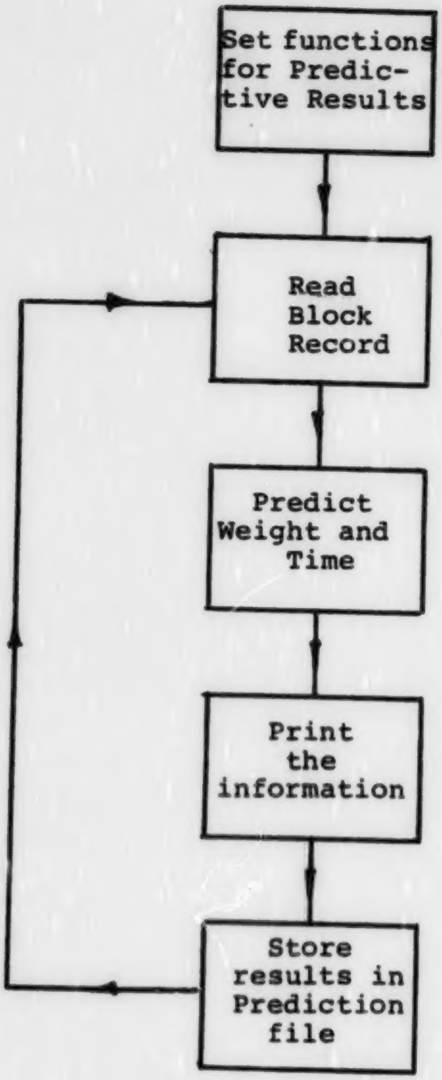

Set functions for Predictive Results
Read Block Record
Predict Weight and Time
Print the information
Store results in Prediction file

Figure 31. Predictive Results

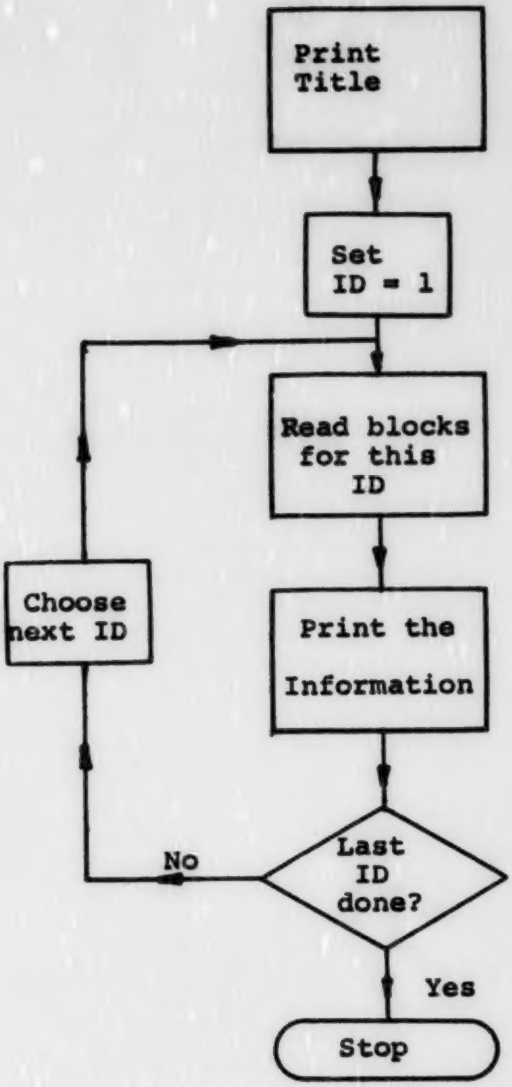

Print Title
Set ID = 1
Read blocks for this ID
Print the Information
Last ID done?
No
Yes
Stop
Choose next ID

Figure 32. ID File Verification

minimal training for operation. Using the Route Design Program, changes could be obtained quickly. The Program incorporated several logic checks to minimize design mistakes, e.g., an error message is printed if a block ID number is entered more than once.

The program requested the user to input ID numbers, one at a time, in any order desired as determined from the ID map. For each new ID number, predicted time and weight, clock time, and cumulative weight was printed. When the truck becomes full, the user was informed and asked to input map distance to the landfill. The clock was then advanced to allow for disposal time. Appropriate provisions were also made for lunch, refueling, and return to garage. In designing a route, the user had the option of deleting one or more ID numbers previously included, in order to assure final route balancing.

The block diagram for this program is given in Figure 33.

Program 13, Route Design (Modified)

This program was similar to Program 12, with a more condensed output. After the user has become familiar with route development using Program 12, an abbreviated output could be obtained with this Program. Warning messages were still displayed during route design, but time and weight data were provided only for completed loads or at the end of the planned work day.

Figure 34 outlines the block diagram of this program.

Program 14, Automatic Route Design

The previous two programs for route design involved manual entry of ID numbers. In order to reduce the time required for route design, an ID Sequence File was established by reading the ID's from the map, starting from the northwest corner of the City. Each ID number was stored in its proper sequence in the ID Sequence File.

After the ID Sequence File was established, it was important that this be verified for any omissions or duplication. To accomplish this, a program was written which scanned the file and reported any discrepancy in the data. Detected errors were then corrected on the terminal system.

The automatic route design program functions exactly like Programs 12 and 13 except that it did not require individual manual input for the ID numbers. The input to the program was read from the ID Sequence File. Minor modifications have been effected on this Program to develop and evaluate the collection system alternatives shown later in Section 7. The block diagram for this Program is given in Figure 35.

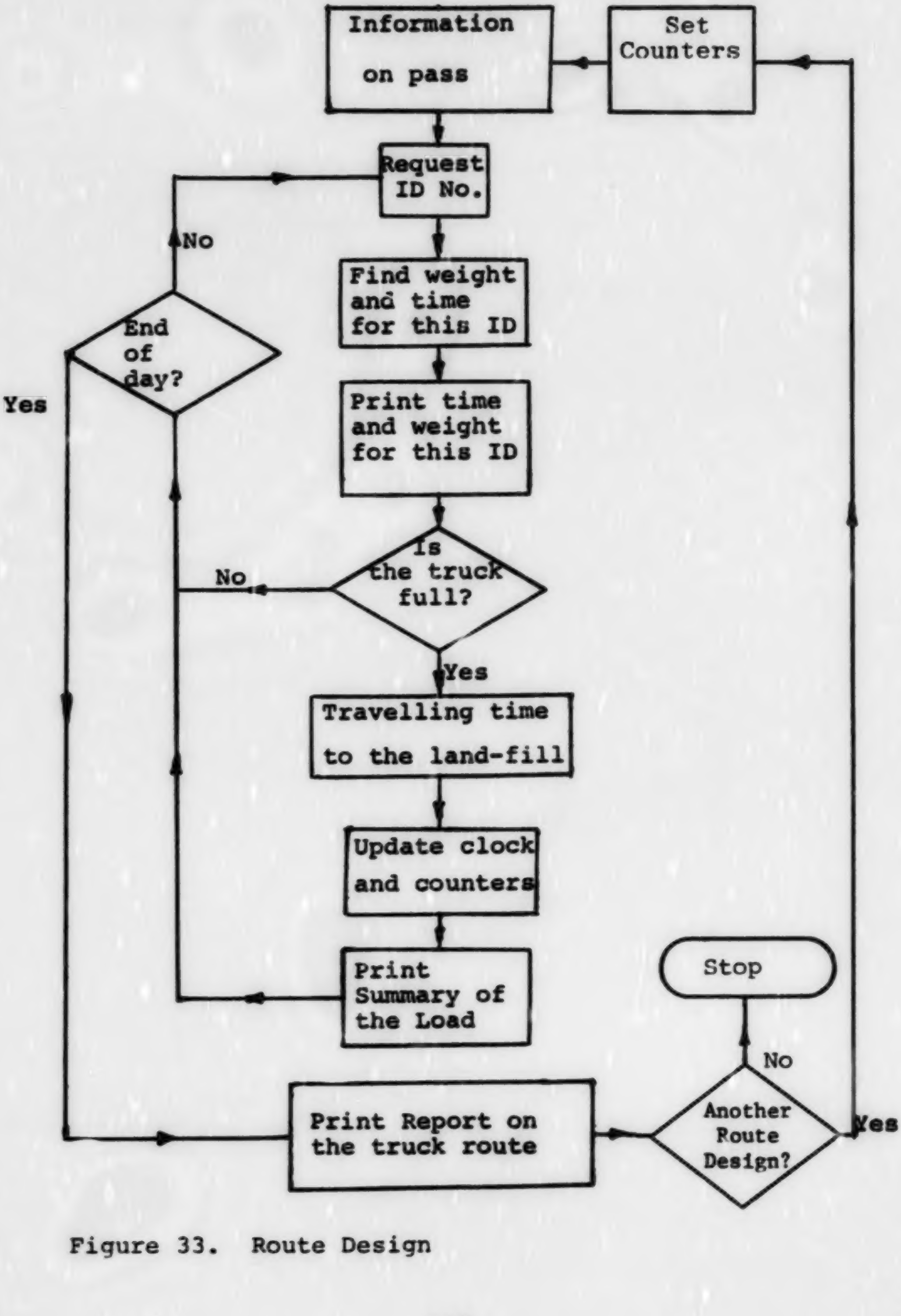

Information on pass
Set Counters
Request ID No.
No
Find weight and time for this ID
End of day?
Yes
Print time and weight for this ID
No
Is the truck full?
Yes
Travelling time to the land-fill
Update clock and counters
Print Summary of the Load
Stop
No
Print Report on the truck route
Another Route Design?
Yes

Figure 33. Route Design

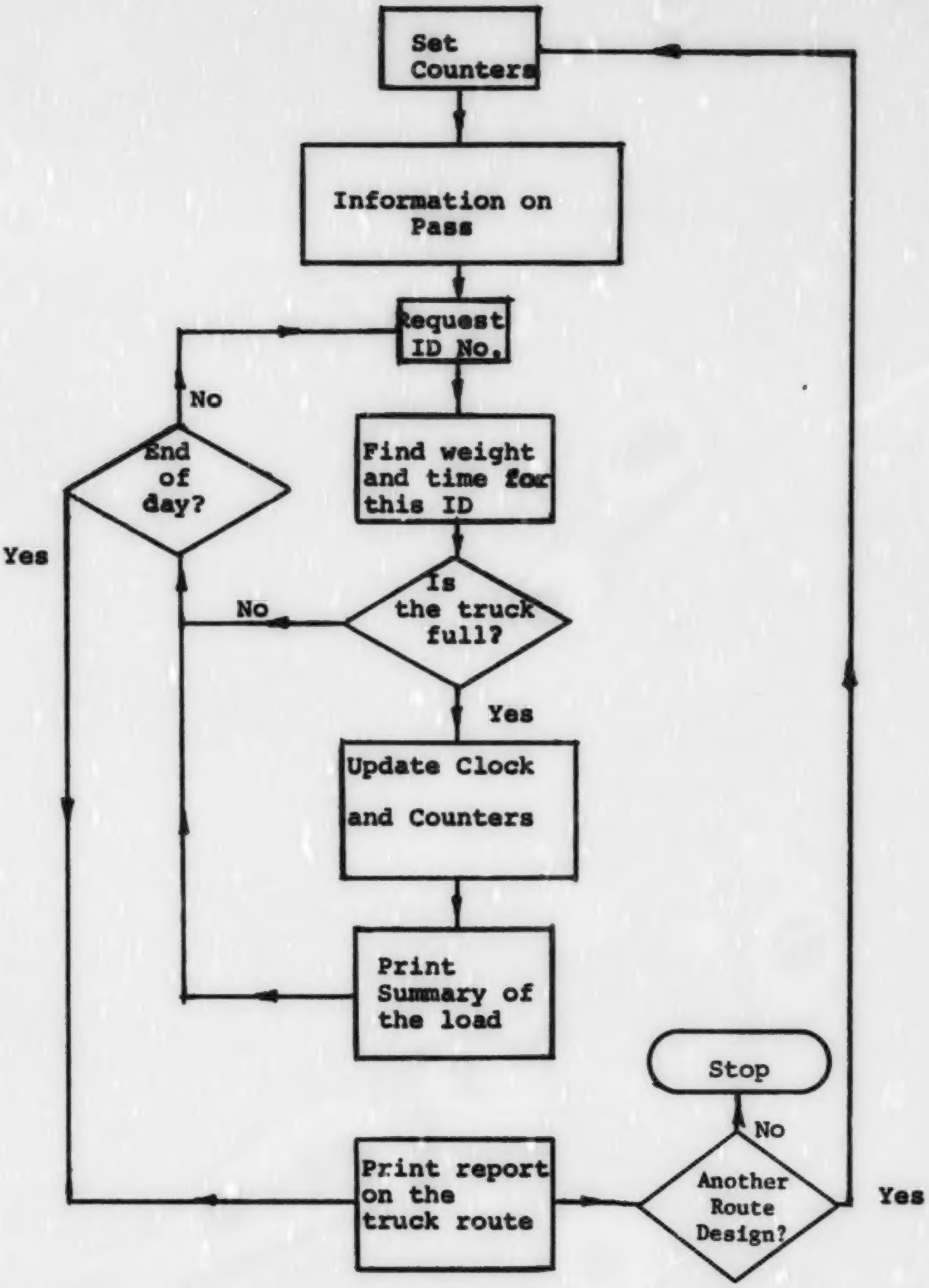

Set Counters
Information on Pass
Request ID No.
Find weight and time for this ID
Is the truck full?
No
Yes
End of day?
No
Yes
Update Clock and Counters
Print Summary of the load
Print report on the truck route
Another Route Design?
Yes
No
Stop

Figure 34. Route Design (Modified)

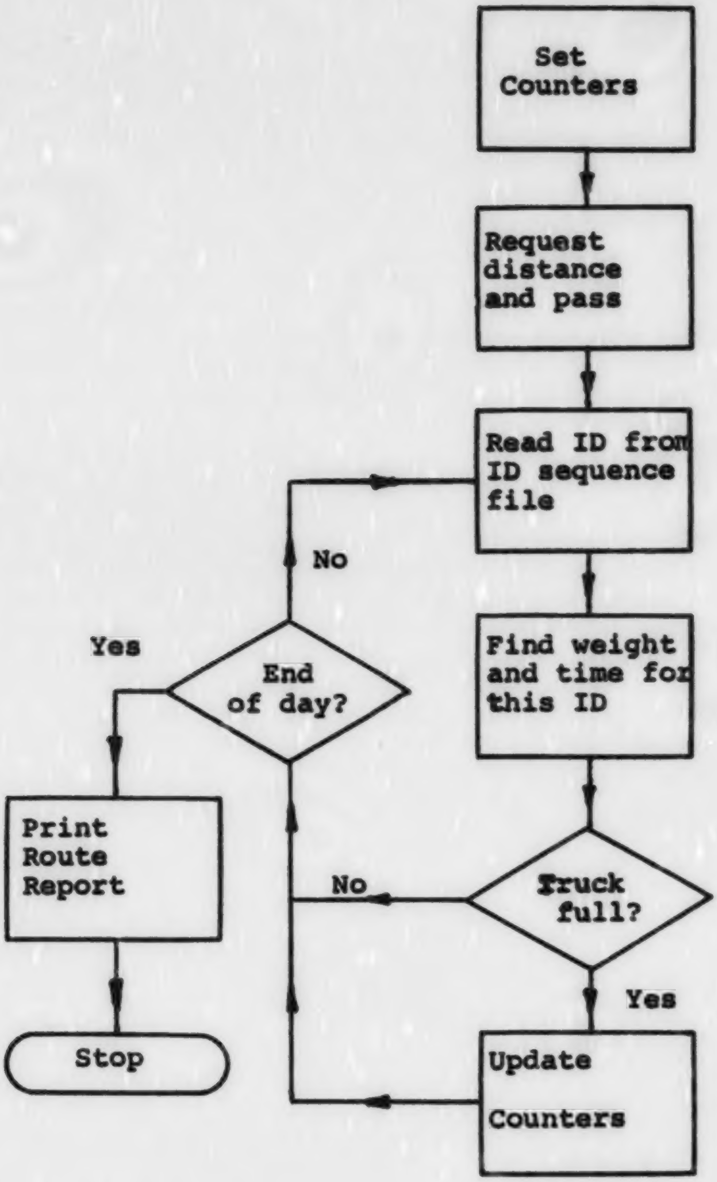

Set Counters
Request distance and pass
Read ID from ID sequence file
Find weight and time for this ID
Truck full?
Yes
No
Update Counters
End of day?
No
Yes
Print Route Report
Stop

Figure 35. Automatic Route Design

OVERALL SYSTEM

The purpose of this subsection is to briefly summarize the relationships and the interactions among all major programs and files beginning with the field survey and continuing through route design. The overall system flow is illustrated in Figure 36.

The first step in the project was to verify the survey data. After verification, a program was run to generate the Block Data File. This File was also verified, and used to classify the blocks in the City into six groups. This generated the Classified Block File and, after sorting, was utilized to obtain the Regression File for regression analysis. The Regression Program used output from the Regression File and yielded several functions that were used for predictive purposes.

At this point, the Block Data File was sorted again to generate the Sorted Block File. The Density Program used field weight data and the Sorted Block File as input and computed densities of solid waste containerization. These densities, equations from the regression analysis, and work measurement data were used to predict the amount of solid waste generated for each block and the time required for its collection. This information was stored in the Prediction File. The ID File for the City and the Prediction File were used as input for designing the routes. All data files for the overall system are listed below:

Block Data File

Classified Block File

ID File

ID Sequence File

Prediction File

Regression File

Sorted Block File

Survey Data File

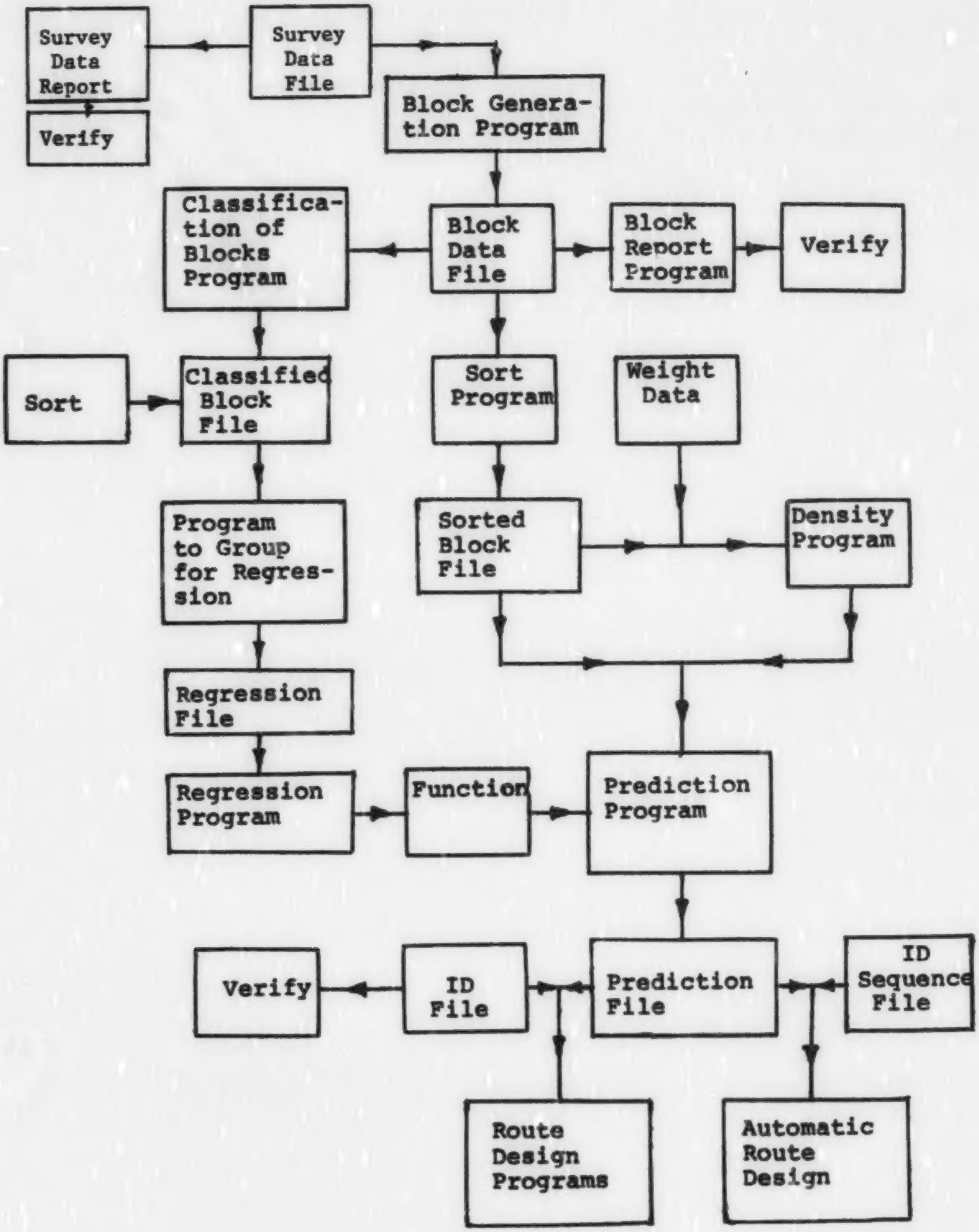

Survey Data Report
Survey Data File
Verify
Block Generation Program
Classification of Blocks Program
Block Data File
Block Report Program
Verify
Sort
Classified Block File
Sort Program
Weight Data
Program to Group for Regression
Sorted Block File
Density Program
Regression File
Regression Program
Function
Prediction Program
Verify
ID File
Prediction File
ID Sequence File
Route Design Programs
Automatic Route Design

Figure 36. Overall System Flow

FOOTNOTES

[1] IEBGENER, "IBM System/360 Operating System: Utilities", Order No. GC28-6586-13, International Business Machines Corporation, Fourteenth Edition (January, 1972), pp. 117-132.

[2] IEBUPDTE, "IBM System/360 Operating System: Utilities", Order No. GC28-6586-13, International Business Machines Corporation, Fourteenth Edition (January, 1972), pp. 179-198.

[3] "OS Sort/Merge Program", Order No. GC28-6543-8, International Business Machines Corporation, Ninth Edition (February, 1973).

[4] "BMD Biomedical Computer Programs", University of California Publications in Automatic Computation, No. 2, (Ed. W. J. Dixon), University of California Press, 1971, pp. 258-275.

7 WASTE COLLECTION ROUTE DEVELOPMENT AND RESULTS

INTRODUCTION

One of the essential ingredients of a successful time or wage incentive program is the capability to predict the work content of waste collection as translated into equitable route assignments. Before describing the development of route assignments, it would be helpful to review the premises on which the route development was structured.

As stated in Section 2, a group incentive is recommended, where each group or team consists of several collection crews and their respective field foreman. The number and size of the teams for a given city is a function of the work content for waste collection, the salient geographical characteristics, and the total size of the collection work force.

Each team is assigned a collection area on a given day. The team works as a cohesive unit under the direction of its foreman, that is, the member crews share the work load until the job is completed. No one leaves work until the team area is totally collected, unless permitted by the foreman.

On a day-to-day basis, the workers have a time incentive, that is, they may leave work on completion of their team's assigned area. For wage incentive programs each team periodically has the opportunity to participate in the review of the length of its standard day, with work increases accompanied by appropriage incentive bonuses.

ALTERNATIVE COLLECTION ROUTE DESIGNS

The technical problem in area route design is to partition the city into team collection areas, each defined in such a way as to provide the desired standard or incentive work day for the team. The total work content must account for all work time elements: the sum of the pickup times (as computed for each block face by the predictive equations, reference Section 5), travel times, disposal time, refueling time, and allowance for unavoidable delays.

An automatic simulation program incorporating all of the above work time elements was utilized to compute the total work content for each collection day. (Program 14 in Section 6). A sample partial output is shown in Appendix 9.7. Fixed inputs to the program included collection frequency, crew size, and length of work day. Output yielded the number of crews required for collection for the entire City.

Six alternative collection area plans were prepared for the Covington City Commission, each providing a standard work week of approximately 32 hours (Table 19 with associated Figures 37 thru 42). All alternatives except II were 5-day work weeks (average 6.5 standard hours per day) while Alternative II was a 4-day week (average 8.0 standard hours per day). Alternatives I, II, III and IV were designed for 3-man crews. Alternatives III-A and IV-A were 2-man crews. Alternatives I, II, III, and III-A provided twice-a-week pickup. Alternatives IV, and IV-A provided once-a-week pickup.

ECONOMIC ANALYSIS AND COST SAVINGS COMPARISON OF WASTE COLLECTION ALTERNATIVES

Annual costs were computed for each collection alternative. All costs for collection were included except certain overhead costs common to all alternatives, e.g., the Public Works Superintendent and staff, supervisory vehicles, building and land use, nonvehicle equipment, backup equipment, and overtime required for Alternatives IV and IV-A (holiday week, Saturday collection).

Annual Costs

The annual cost for each collection alternative may be estimated as follows:

Annual Cost = Truck Cost + Crew Cost + Overhead

1) Truck Cost

Capital Costs:

First Cost (P) = $15,000
Salvage Value (F) = $ 500
Capital Recovery
Factor (A/P):

$$A/P = \frac{i(1+1)^n}{(1+i)^n-1}$$

TABLE 19. COMPARISON OF WASTE COLLECTION ALTERNATIVES

	DESCRIPTION	AVG. WORK DAY (HOURS)	STRENGTHS	WEAKNESSES
ORIGINAL				
	5-day collection; 5-day work week; twice-a-week pickup	8.0	MH and TF collection	Unbalanced routes No special item pickup
				No time incentive
	Total crews: 13 Res. and Comm. (3-man)			Inequitable commercial/ institutional service
ALT. I				
	5-day collection; 5-day work week; twice-a-week pickup	6.5	Utilizes crews all 5 days	Certain Areas with T-H, M-W, W-F pickup
	Total crews: 8 Res. (3-man) 2 Comm. (2-man) 10		Extra commercial route capacity	Route Areas more complex with Team I split on Wed.
			Special Item pickup by Comm. crews for W	Uncertainty of T-H, M-W and W-F pickup schedule on waste volume
				Holiday week collection more difficult
ALT. II				
	4-day collection; 4-day work week; twice-a-week pickup	MT: 8.5 HF: 7.5	MH and TF Collection	Long days, with M and T requiring approximately 8 1/2 hours
	Total crews: 8 Res. (3-man) 2 Comm. (2-man) 10		Utilizes crews all 4 days	Greater difficulty with late-afternoon traffic
			Special item pickup by comm. crews added for M, T, H, F	Collection service not available on Wed.
			Simple route areas	Possible difficulties with 4-day week; requires union renegotiation of working agreement

TABLE 19 (CONT.)

ALT. III	DESCRIPTION	AVG. WORK DAY HOURS	STRENGTHS	WEAKNESSES
	4-day collection; 5-day work week; twice-a-week pickup	MT: 7.0 HF: 6.0	M-H and T-F collection	Management of Wednesday assignments
	Total crews: 10 Res. (3-man) 2 Comm. (2-man) 12		Extra commercial route capacity Special item pickup added on Wednesday Simple route areas	More restricted special item pickup
ALT. III A				
	4-day collection; 5-day work week; twice-a-week pickup	MT: 7.0 HF: 6.0	M-H and T-F collection	Management of Wednesday assignments
	Total crews: 12 Res. (2-man) 2 Comm. (2-man) 14		Extra commercial route capacity Special item pickup added on Wednesday Simple route areas	More restricted special item pickup

TABLE 19 (CONT.)

ALT. IV	DESCRIPTION	AVG. WORK DAY HOURS	STRENGTHS	WEAKNESSES
	5-day collection; 5-day work week; once-a-week pickup Total crews: 6 Res. (3-man) 2 Comm. (2-man) 8	6.5	Utilizes crews all 5 days Extra commercial route capacity Special item pickup by commercial crews added for Wednesday Simple route areas	Once-a-week pickup Requires overtime pay for holiday work weeks (Saturday collection)
ALT. IV A				
	5-day collection 5-day work week; once-a-week pickup Total crews: 8 Res. (2-man) 2 Comm. (2-man) 10	6.5	Utilizes crews all five days Extra commercial route capacity Special item pickup by commercial crews added for Wednesday Simple route areas	Once-a-week pickup Requires overtime pay for holiday work weeks (Saturday collection)

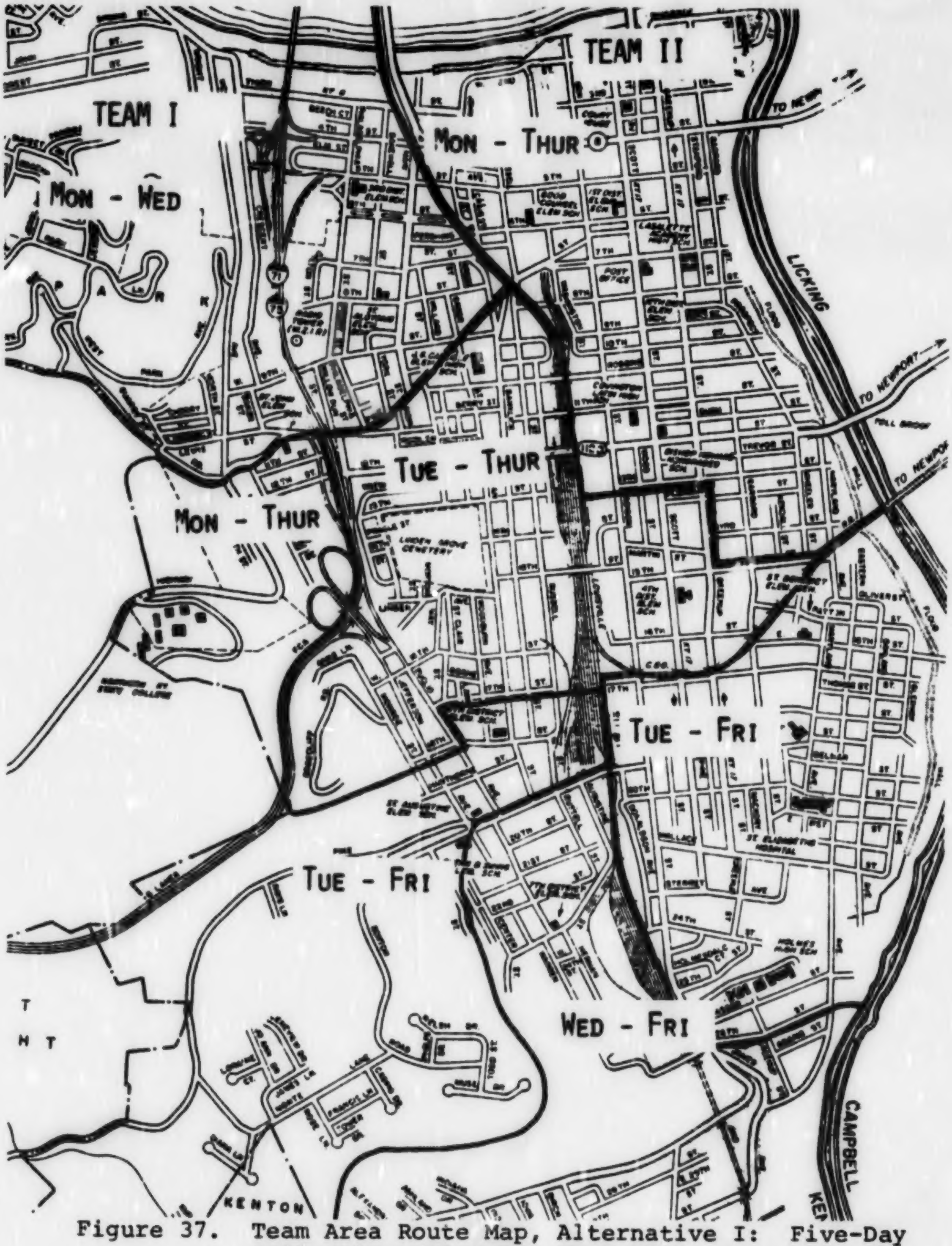

TEAM I
MON - WED
TEAM II
MON - THUR
TUE - THUR
MON - THUR
TUE - FRI
TUE - FRI
WED - FRI
TO NEWPORT
TO NEWPORT
LICKING
CAMPBELL
KENTON

Figure 37. Team Area Route Map, Alternative I: Five-Day Collection; Five-Day Work Week; Twice-a-Week Pickup; Three-Man Crew

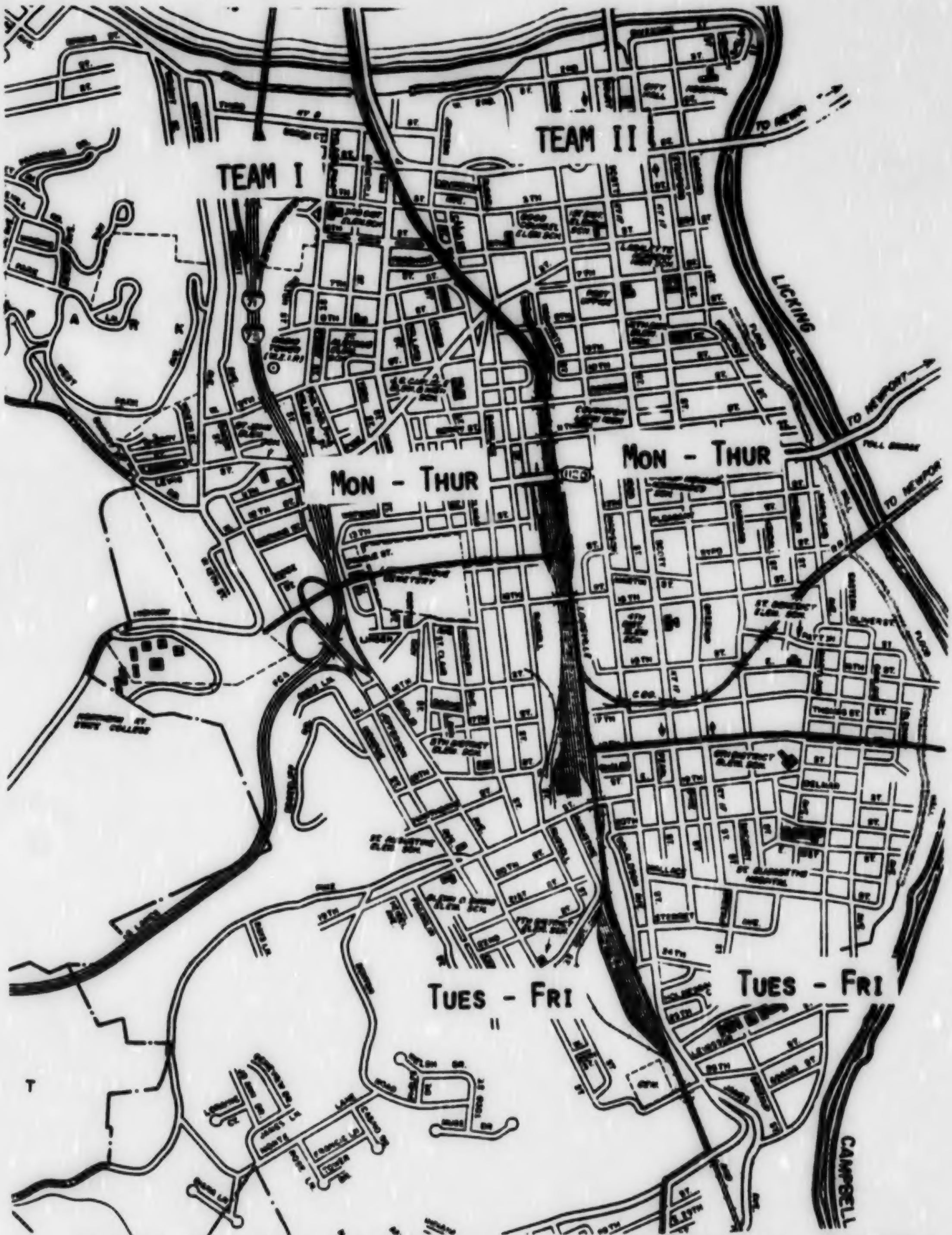

TEAM I
TEAM II
MON - THUR
MON - THUR
TUES - FRI
TUES - FRI
LICKING
TO NEWPORT
TO NEWPORT
CAMPBELL

Figure 38. Team Area Route Map, Alternative II: Four-Day Collection; Four-Day Work Week; Twice-a-Week Pickup; Three-Man Crew

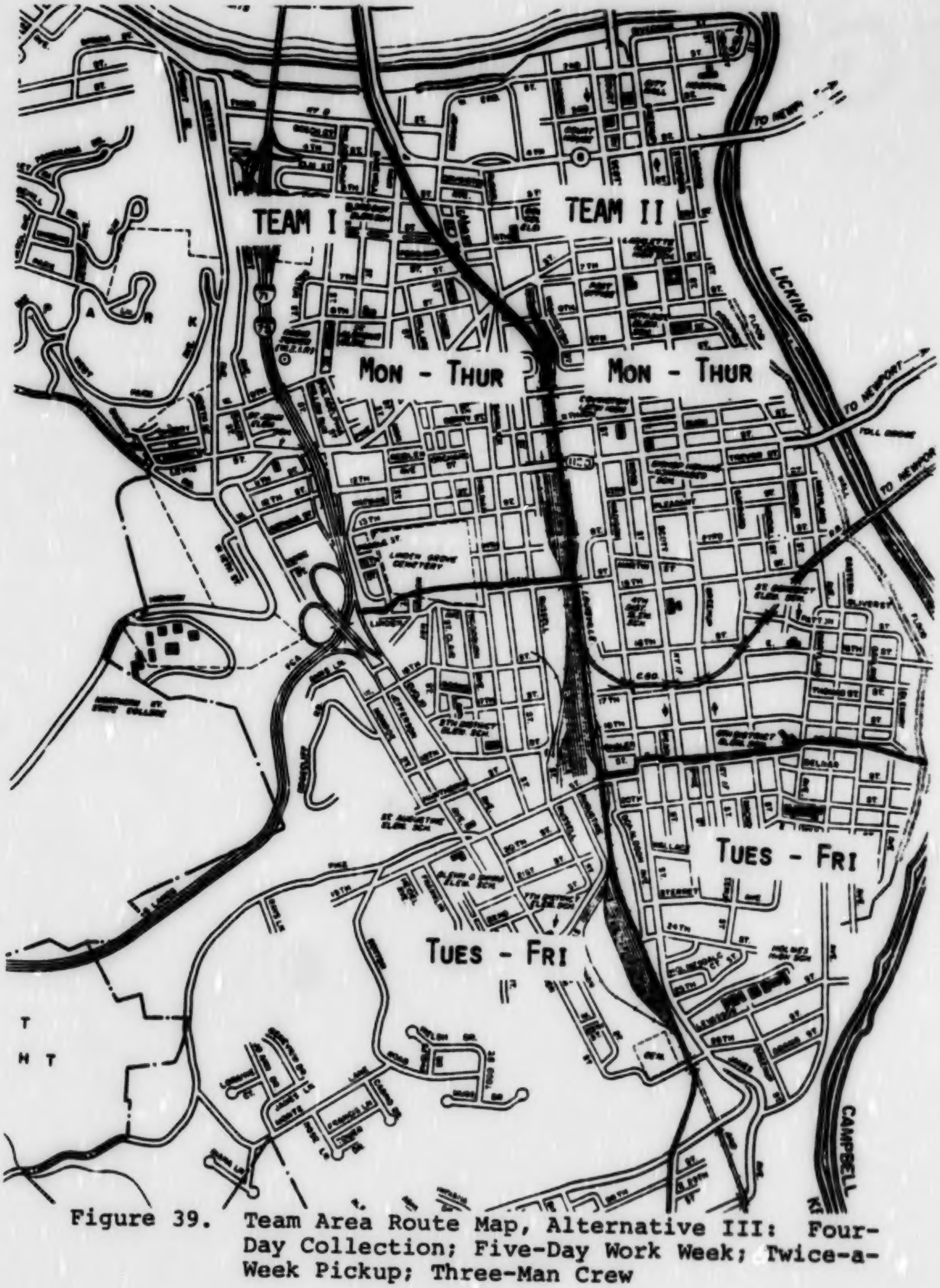

TEAM I
TEAM II
MON - THUR
MON - THUR
TUES - FRI
TUES - FRI
LICKING
CAMPBELL
TO NEWPORT
P A R K
LINDEN GROVE CEMETERY

Figure 39. Team Area Route Map, Alternative III: Four-Day Collection; Five-Day Work Week; Twice-a-Week Pickup; Three-Man Crew

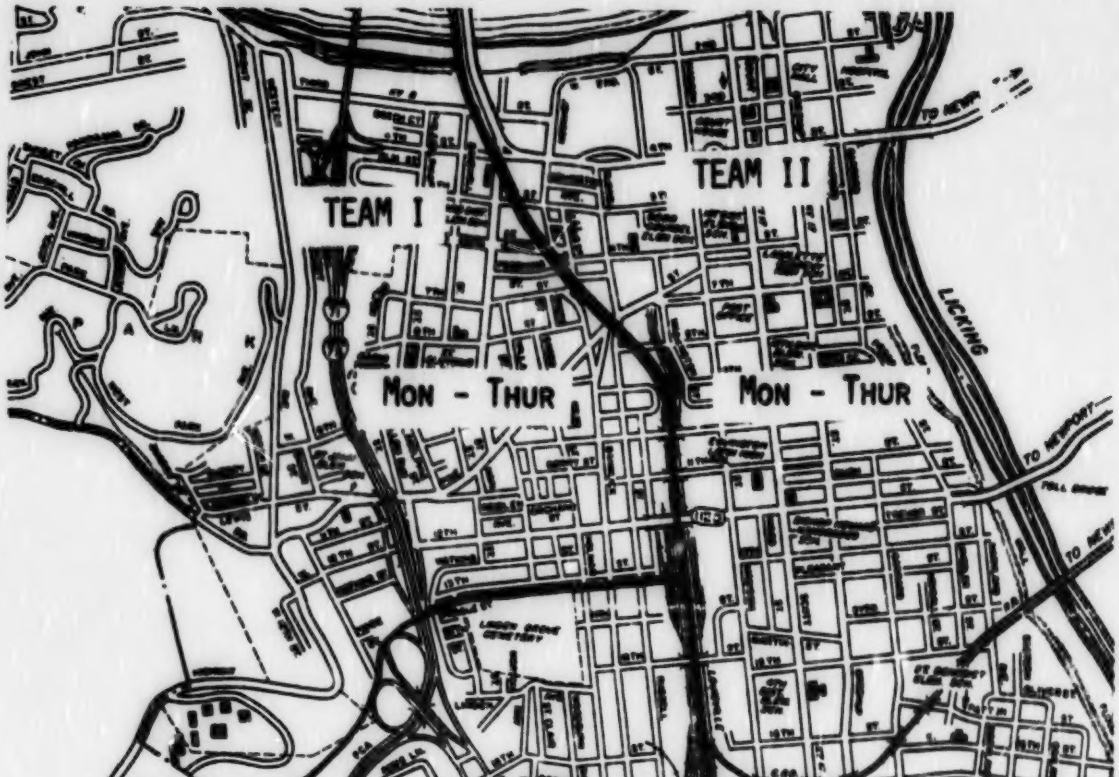

TEAM I
TEAM II
MON - THUR
MON - THUR
TUES - FRI
TUES - FRI
LICKING
TO NEWPORT
CAMPBELL
KENTON

Figure 40. Team Area Route Map, Alternative III-A: Four-Day Collection; Five-Day Work Week; Twice-a-Week Pickup; Two-Man Crew

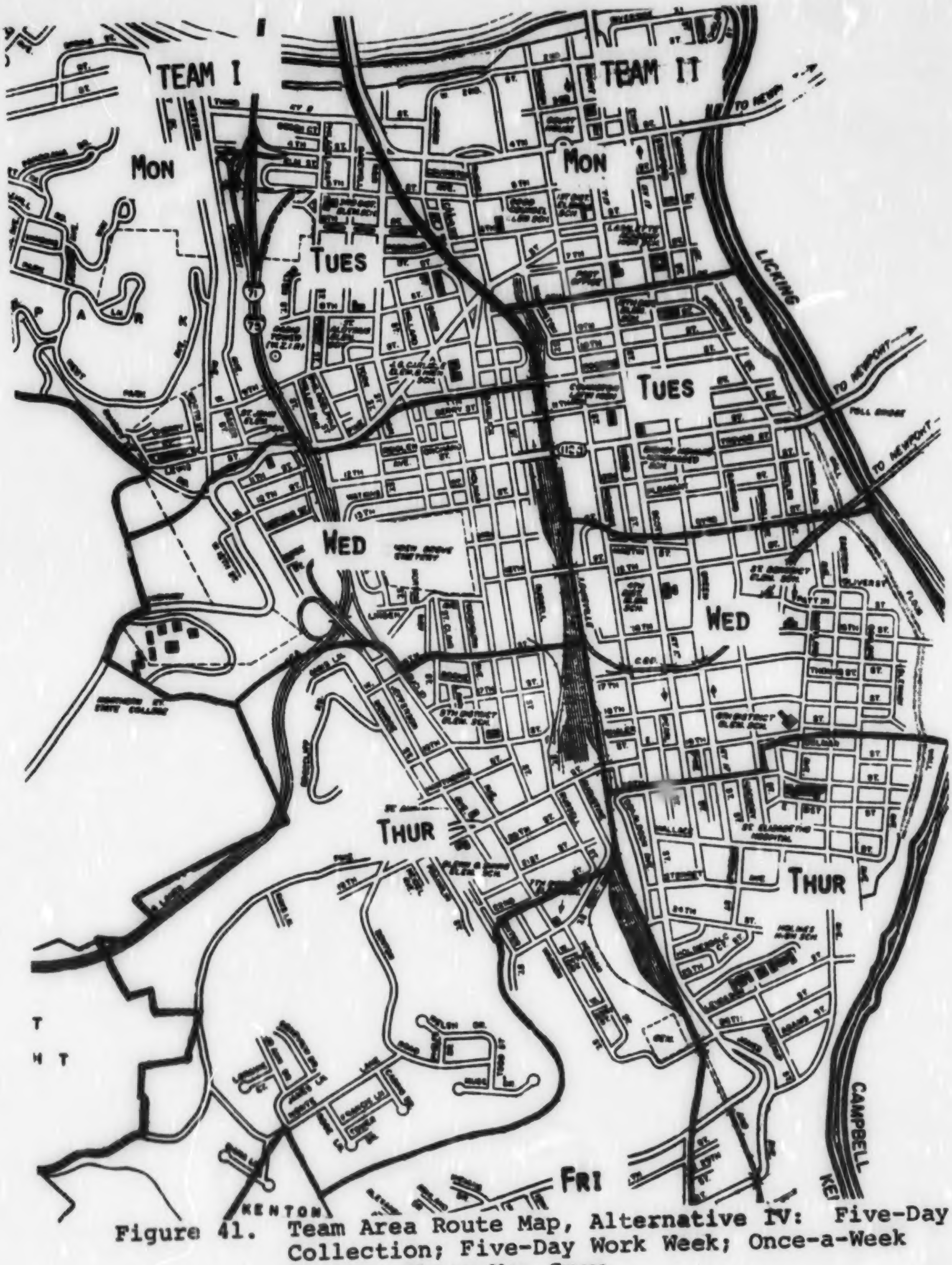

TEAM I
TEAM II
MON
MON
TUES
TUES
WED
WED
THUR
THUR
FRI
LICKING
TO NEWPORT
TO NEWPORT
TO NEWPORT
CAMPBELL
KENTON

Figure 41. Team Area Route Map, Alternative IV: Five-Day Collection; Five-Day Work Week; Once-a-Week Pickup; Three-Man Crew

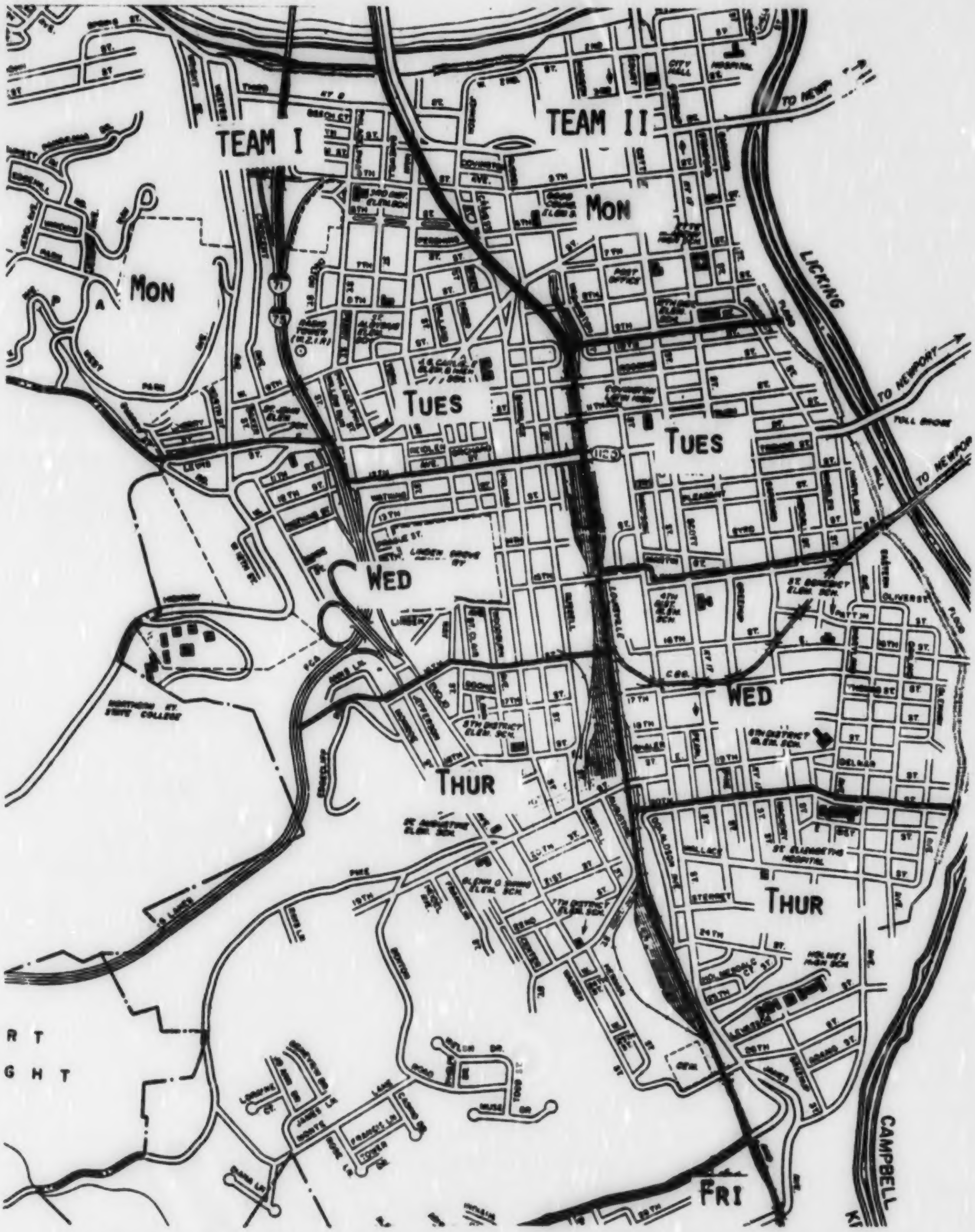

TEAM I
TEAM II
MON
MON
TUES
TUES
WED
WED
THUR
THUR
FRI
LICKING
TO NEWPORT
TO NEWPORT
TOLL BRIDGE
CAMPBELL
CITY HALL
POST OFFICE
NORTHERN KY. STATE COLLEGE
ST. ELIZABETH HOSPITAL
HOLMES HIGH SCH.

Figure 42. Team Area Route Map, Alternative IV-A: Five-Day Collection; Five-Day Work Week; Once-a-Week Pickup; Two-Man Crew

where:

i = annual interest = 8 percent
n = life in years = 5

$$A/P = \frac{0.08(1.08)^5}{(1.08)^5-1} = 0.2505$$

Sinking Fund Factor (A/F):

$$A/F = \frac{i}{(1+i)^n-1}$$

$$A/F = \frac{0.08}{(1.08)^5-1} = 0.1705$$

Equivalent Annual Capital Cost (A) = \$15,000(.2505) - \$500(.1705)
= \$3673/Truck

Operating Costs:

Fuels, Lubricants	=	\$14.00/Truck-day
Tires, Maintenance Supplies	=	5.00
Subtotal	=	\$19.00/Truck-day

Total Truck Costs:

Total Cost = Capital Cost + Operating Cost

5-day collection: \$3,673 + (\$19)(52)(5) = \$8,613/truck

4-day collection: \$3,673 + (\$19)(52)(4) = \$7,625/truck

2) Crew Cost

Drivers:

Wages	\$153.60/week
Pensions (20%)(wages)	30.72
Soc. Sec. (5.85%)(wages)	8.99
Workmen's Comp.(6%)(wages)	9.22
Medical \$594 ÷ 52	11.42
Subtotal	\$213.95/week
	\$11,125.40/year

Laborers:

Wages		$145.15/week
Pension, Social Security Workmen's Comp. (31.85%) (wages)		46.23
Medical		11.42
	Subtotal	$202.80/week
		$10,545.60/year

3) Overhead

Supervisory Personnel:

Assistant Superintendent

Wages		$234.21/week
Pension, Social Security Workmen's Comp.		74.60
Medical		11.42
	Subtotal	$320.23/week
		$16,651.96/year

Foreman

Wages		$188.24/week
Pension, Social Security Workmen's Comp.		59.95
Medical		11.42
	Subtotal	$259.61/week
		$13,499.72/year

Maintenance Personnel

Wages		$165.00/week
Pension, Social Security Workmen's Comp.		52.55
Medical		11.42
	Subtotal	$228.97/week
		$11,906.44/year

Indirect Savings From Manpower "Available" on Wednesdays

Alternatives III and III-A provided four day collection in a five day work week. Consequently, manpower was available on Wednesdays for other waste collection assignments. Because all workers would receive pay for Wednesday, these indirect savings are not included in the annual savings comparison summary (Figure 43).

1) Driver:

$$\left(\frac{\text{42 nonholiday wks.}}{\text{52 wks./yr.}}\right)\left(\frac{\text{1 day/wk.}}{\text{5 days/wk.}}\right)(\$11{,}125.40) = \$1797/\text{driver}$$

2) Laborer:

$$\left(\frac{42}{52}\right)\left(\frac{1}{5}\right)(10{,}545.60) = \$1703/\text{laborer}$$

3) Foreman:

$$\left(\frac{42}{52}\right)\left(\frac{1}{5}\right)(\$13{,}499.72) = \$2180/\text{foreman}$$

Economic Comparison of Alternatives

1) Original System (5-day pickup)

13 trucks @ $8,613.00	$111,969	
13 drivers @ $11,125.40	144,630	
26 laborers @ $10,545.60	274,186	
Overhead		
1 asst. superintendent @ $16,651.96	16,652	$55,557
2 foremen @ $13,499.72	26,999	
1 maintenance @ $11,906.44	11,906	
Total	$586,342	

2) Alt. I (5-day pickup, twice a week)

10 trucks @ $8,613	$ 86,130
10 drivers @ $11,125.40	111,254
18 laborers @ 10,545.60	189,821
Overhead	55,557
Total	$442,762
Direct Savings Over Original	$143,580/year

3) Alt. II (4-day week, 4-day pickup, twice a week)

10 trucks @ $7,625	$ 76,250
10 drivers @ $11,125.40	111,254
18 laborers @ $10,545.60	189,821
Overhead	55,557
Total	$432,881
Direct Savings Over Original	$153,461/year

4) Alt. III (4-day pickup, twice a week)

12 trucks @ $7,625	$ 91,500
12 drivers @ $11,125.40	133,505
22 laborers @ $10,545.60	232,003
Overhead	55,557
Total	$512,565
Direct Savings Over Original	$ 73,777
Savings from available manpower on Wed. (12 drivers, 22 laborers, 2 foremen)	63,401
Total Savings Over Original	$137,178/year

5) Alt. III-A (4-day pickup, twice a week)

14 trucks @ $7,625	$106,750
28 drivers @ $11,125.40	311,511
Overhead	55,557
Total	$473,818
Direct Savings	$112,524
Savings from available manpower on Wed. (28 drivers)	54,677
Total Savings	$167,201/year

6) Alt. IV (5-day pickup, once a week)

8 trucks @ $8,613		$ 68,904
8 drivers @ $11,125.40		89,003
14 laborers @ $10,545.60		147,638
Overhead		55,557
	Total	$361,102
	Savings	$225,240/year

7) Alt. IV-A (5-day pickup, once a week)

10 trucks @ $8,613		$ 86,130
20 drivers @ $11,125.40		225,508
Overhead		55,557
	Total	$364,195
	Savings	$222,147/year

A summary of annual cost savings for each collection alternative is shown in Figure 43.

IMPLEMENTATION

Six collection alternatives were developed for City Commission consideration. Comparisons of each were provided to aid the Commission in selection of an alternative for implementation. In preparation for implementation, tasks and schedules were outlined.

Tasks

The following list of tasks was utilized for implementation:

1) Commission: Select alternative.

2) Commission: Approve enacting ordinances. Sample ordinances for once-a-week and twice-a-week collection are given in Appendices 9.10 and 9.11.

3) City Manager's Office and U.C. Planners: Meet with Union management for information and discussion, followed by meetings with the membership if requested.

4) City Manager's Office and U.C. Planners: Arrange for preliminary public information explaining salient characteristics of the new system, including benefits,

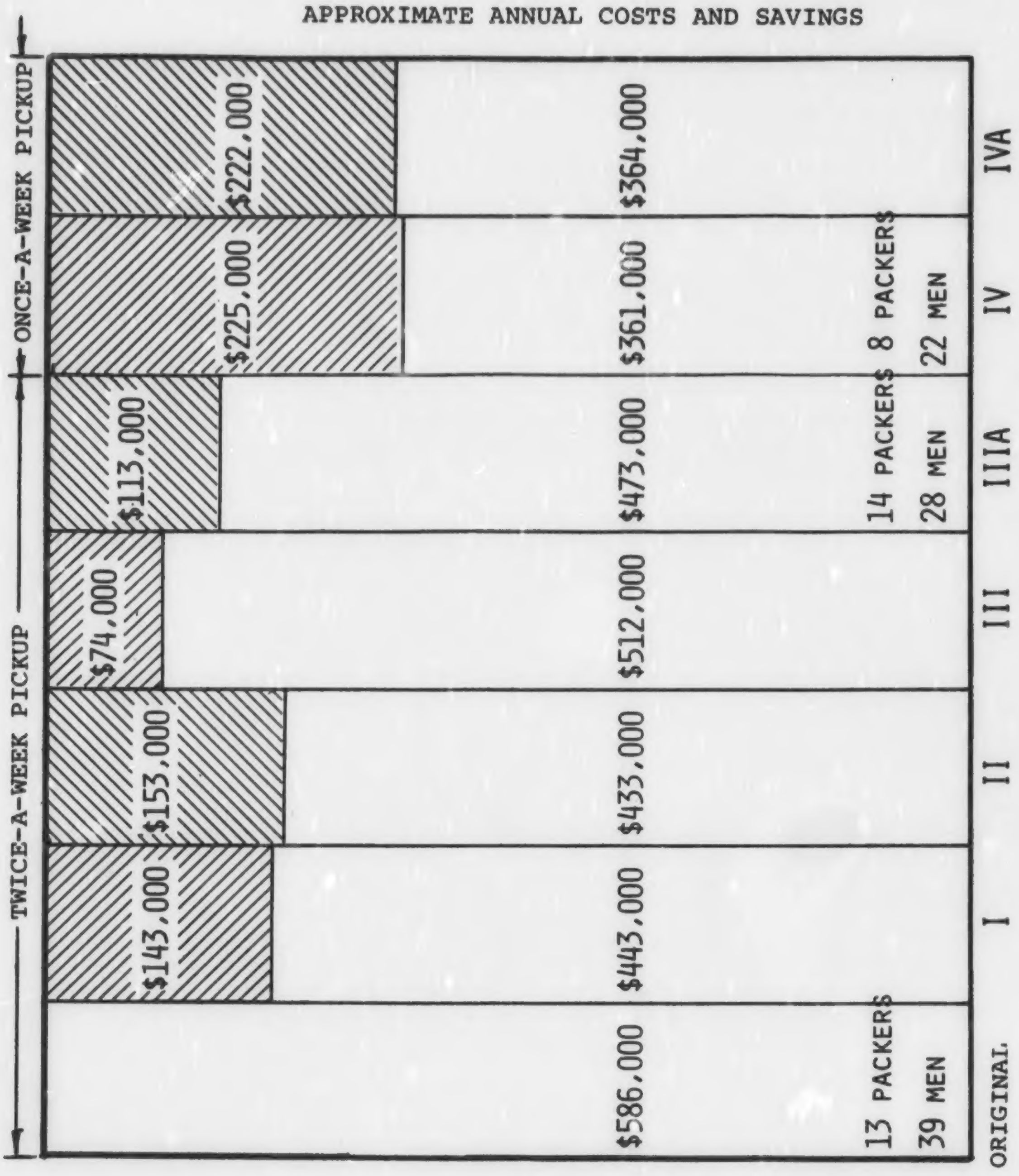


Figure 43. Annual Savings Comparison of Six Waste Collection Alternatives (With Original Cost)

savings, and new services.

5) City Manager's Office and Public Works Management: Review existing Public Works two-way communication system.

6) Public Works Management: Select the crew/team assignments and notify men.

7) Public Works Management: Explain incentive program to employees.

8) Public Works Management and U.C. Planners: Finalize team and truck route area assignments.

9) Public Works Management: Contact all existing and prospective high volume citizens to determine collection frequency and containerization for each new high volume stop.

10) City Manager's Office and Public Works Management: Establish accounting/billing system for high volume optional services.

11) Public Works Management and U.C. Planners: Develop initial high volume routes.

12) Public Works Management: Plan special item pickup.

13) City Manager's Office: Inform citizens of new routes, procedures for special item pickup, and implementation schedule. A sample announcement for citizen notification is shown in Appendix 9.12.

Final Schedule

After completion of the above tasks and immediately preceding implementation, the following schedule is recommended:

1) U.C. Planners: Meet with team foremen to discuss team crews, truck areas, and foremen's role. Time: Monday before D-Day.

2) U.C. Planners: Meet with foremen and drivers to discuss team areas, truck areas, and hand out maps. Time: Wednesday before D-Day.

3) U.C. Planners and all collection personnel: Dry run of loadpackers over assigned route areas. Time: Saturday before D-Day.

4) U.C. Planners and all collection personnel: Changeover to new collection systems. Time: Monday, D-Day.

5) U.C. Planners and all collection personnel: Accompany field foremen during the initial operation of the new routes. Time: First five days following D-Day.

First Implementation - August 5, 1974

During July, 1974, after several weeks of consideration, the City Commission selected Alternative III-A. This alternative continued twice-a-week collection service, but reduced crew size from three to two. Appendix 9.13 illustrates the coverage provided the implementation by one of the local newspapers. Upon selection of Alternative III-A, the tasks and schedules were followed by all parties, as previously outlined. Citizens were notified of the new collection schedule by radio, TV, and newspaper advertisements (Appendix 9.14). Utilizing the sociometric analysis described in Section 3, team assignments were prepared on the basis of individual preferences. The results are shown in Appendix 9.15. Area route assignments for all truck crews were prepared using the detail route design computer program (Program 13, Section 6). Example computer outputs for Team I and Team II are shown in Appendices 9.8 and 9.9. Truck route maps as shown in Figures 44, 45, 46, and 47 were provided to all drivers and foremen. In addition, driver and foreman guidelines (Appendices 9.16 and 9.17) were handed out during the training sessions.

Second Implementation - April 14, 1975

After several months of successful operation of Alternative III-A, during the final phases of budget planning for the next fiscal year, it became apparent to City management that a substantial financial deficit would occur. Consequently, further operating budget reductions would be necessary. In the Department of Public Works, it was recommended that collection frequency be reduced from twice to once weekly. In March, 1975, the Commission made the decision to implement Alternative IV, which offered the lowest costs for waste collection.

As a result of this decision, tasks and a schedule similar to the first implementation were followed. New area route maps as shown in Figures 48, 49, 50, and 51 were prepared and distributed to all truck crews and foremen. An example citizen notification map is shown in Figure 52. The areas shown in Figure 52 for each collection day conform to the detail crew route area maps as shown in Figure 50.

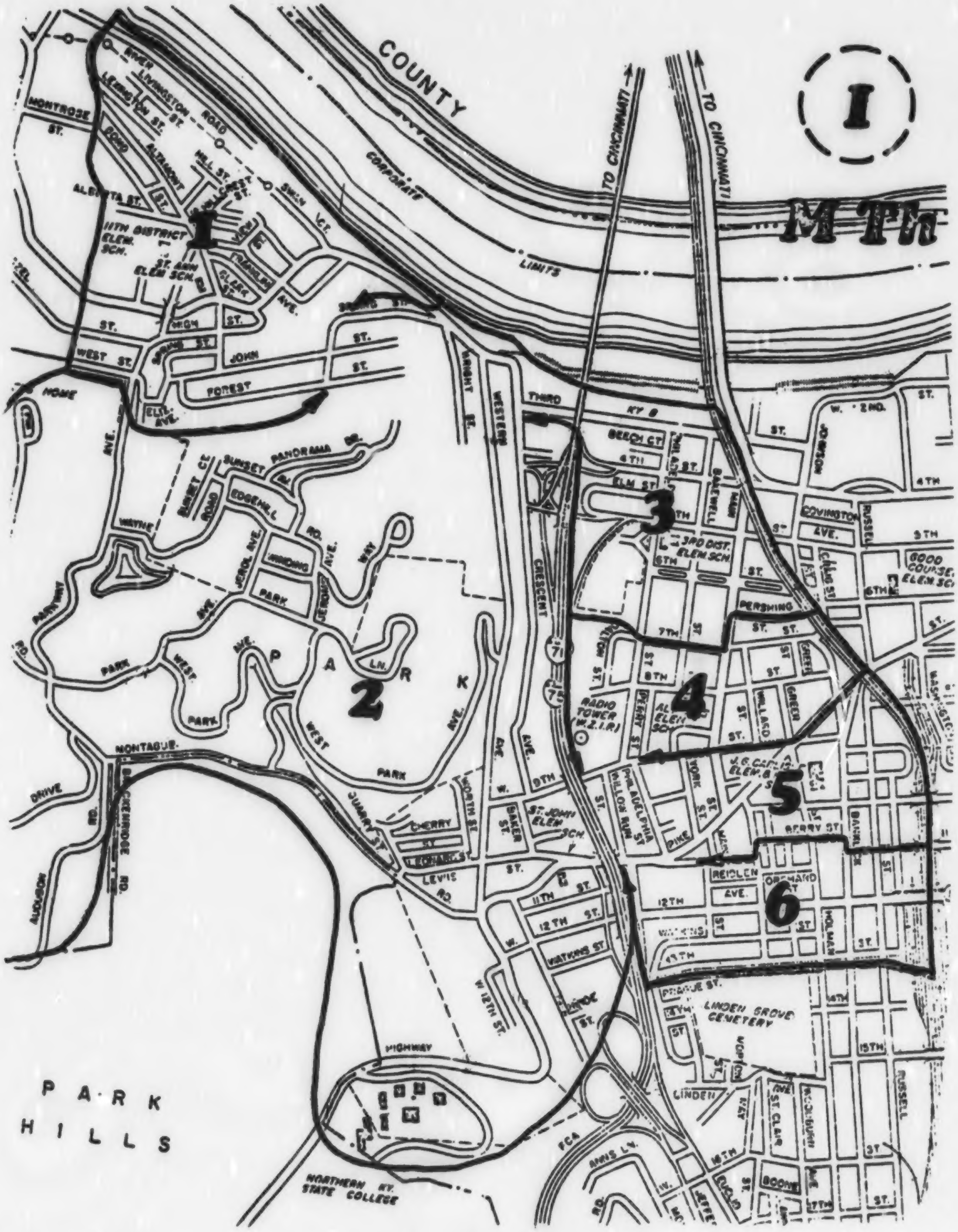

I
COUNTY
CORPORATE
LIMITS
TO CINCINNATI
TO CINCINNATI
M Th
1
2
3
4
5
6
RIVER
LIVINGSTON
ROAD
LEXINGTON ST.
MONTROSE ST.
ALTAMONT
HILL ST.
ALBERTA ST.
11TH DISTRICT ELEM. SCH.
ST. ANN ELEM SCH.
WEST ST.
JOHN ST.
FOREST ST.
HOME
ELM AVE.
BRIGHT ST.
WESTERN AVE.
THIRD
KY 8
W. 2ND
ST.
JOHNSON
4TH
BEECH CT.
ELM ST.
PHILADELPHIA
BAKEWELL
MAIN
COVINGTON AVE.
RUSSELL
3RD DIST. ELEM SCH.
GOOD COUNSEL ELEM SCH.
PERSHING
7TH
8TH
9TH
RADIO TOWER (W.Z.I.R.)
PERRY ST.
WILLARD
GREER
YORK ST.
PIKE
BERRY ST.
ORCHARD ST.
REIDLEN AVE.
HOLMAN
12TH
WATKINS ST.
13TH
PRAGUE ST.
LINDEN GROVE CEMETERY
15TH
16TH
17TH
LINDEN
ST. CLAIR
BOONE
EUCLID
ANNIS LN.
71
75
CRESCENT AVE.
SUNSET
PANORAMA DR.
EDGEHILL RD.
WINDING WAY
JEROME AVE.
PARK AVE.
WEST PARK AVE.
PARKWAY
P A R K
MONTAGUE
DRIVE
AUDUBON
BRECKENRIDGE RD.
CHERRY ST.
LEONARD ST.
LEWIS RD.
BAKER ST.
NORTH ST.
ST. JOHN ELEM SCH
11TH ST.
12TH ST.
WATKINS ST.
HIGHWAY
PARK HILLS
NORTHERN KY. STATE COLLEGE

Figure 44. Truck Area Route Maps for Team I Mon-Thur Collection, Alternative III-A

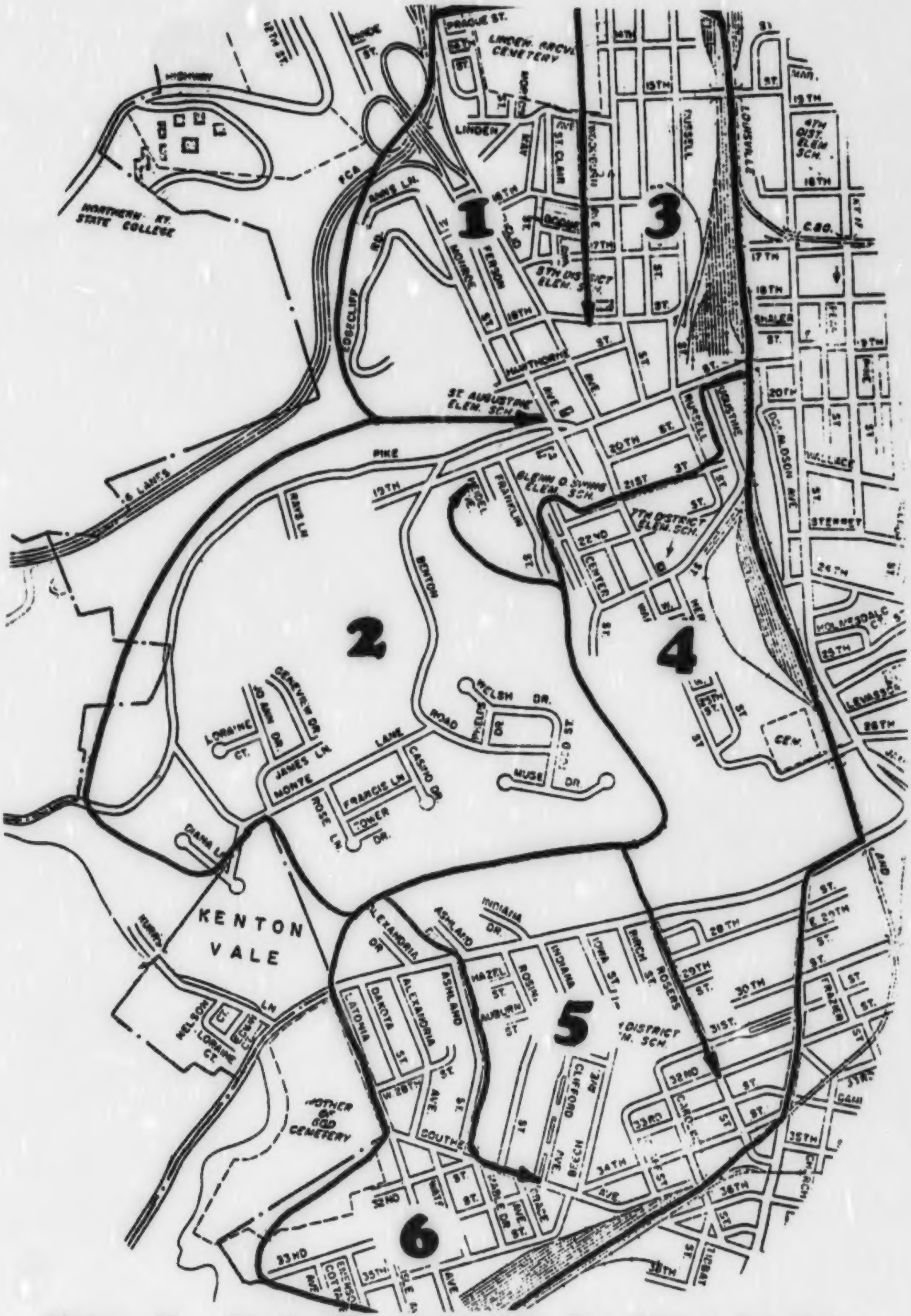
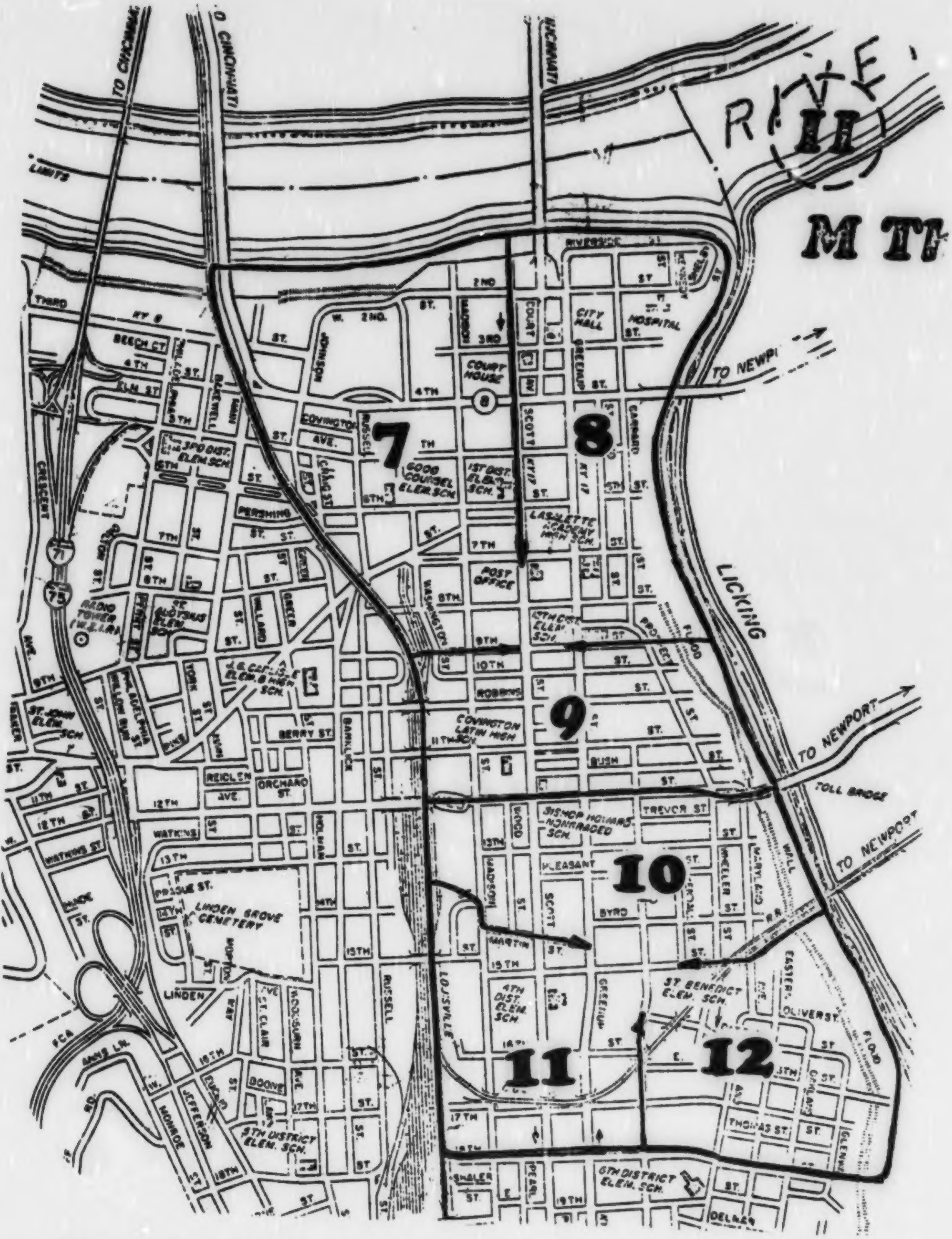
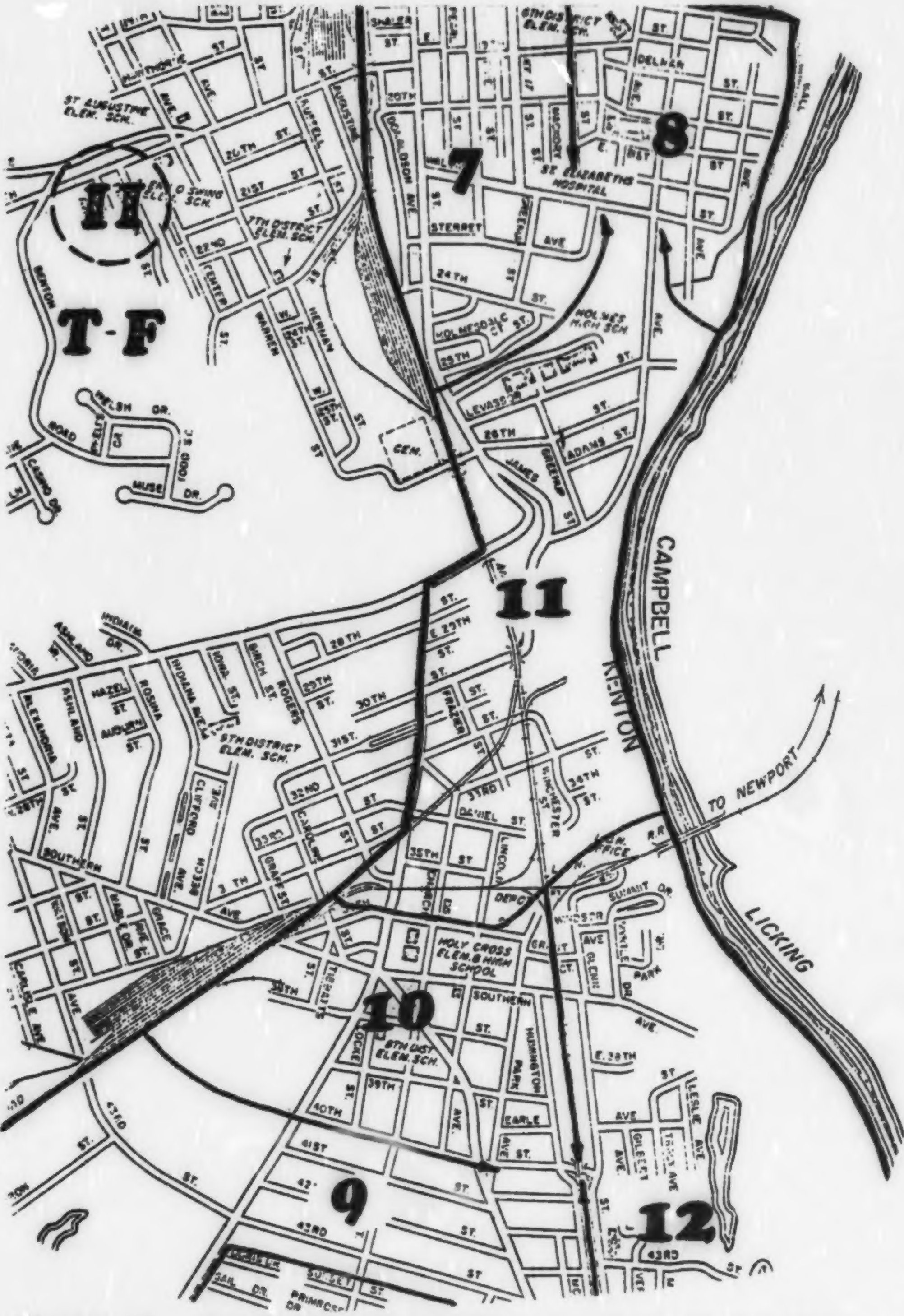

1
2
3
4
5
6
KENTON VALE
NORTHERN KY. STATE COLLEGE
LINDEN ARCVL CEMETERY
PRAGUE ST.
12TH ST.
HIGHWAY
LINDEN
ST. CLAIR
RUSSELL
LOUISVILLE
4TH DIST. ELEM. SCH.
C.&O.
18TH
17TH
SHALER ST.
5TH DISTRICT ELEM. SCH.
MONROE
FERSON
EDGECLIFF RD.
ANNS LN.
HAWTHORNE ST.
ST. AUGUSTINE ELEM. SCH.
PIKE
6 LANES
20TH ST.
21ST ST.
WALLACE
DC. ALDSON AVE
STERRETT
ELENN O. SWING ELEM. SCH.
7TH DISTRICT ELEM. SCH.
22ND
CENTER ST.
FRANKLIN ST.
19TH
BENTON ROAD
24TH
25TH
26TH
HOLMESDALE CT.
CEM.
WELSH DR.
MUSE DR.
GENEVIEW DR.
LORAINE CT.
JAMES LN.
MONTE LANE
FRANCIS LN.
ROSE LN.
TOWER DR.
CASINO DR.
DIANA LN.
NELSON CT.
LORAINE CT.
MOTHER OF GOD CEMETERY
ALEXANDRIA DR.
ASHLAND
INDIANA DR.
28TH
29TH ST.
30TH
31ST.
32ND
33RD
34TH
35TH
36TH
38TH
LATONIA
DAKOTA ST.
ALEXANDRIA
HAZEL ST.
AUBURN ST.
ROSINA
INDIANA
IOWA ST.
BIRCH ST.
ROGERS
CLIFFORD AVE.
BEECH AVE.
FRAZIER
CHURCH
DISTRICT ELEM. SCH.
SOUTHERN
GRACE
W. 28TH
33RD
35TH
COTTAGE

Figure 45. Truck Area Route Maps for Team I Tue-Fri Collection, Alternative III-A



RIVER
II
M TH
TO CINCINNATI
TO CINCINNATI
CINCINNATI
LIMITS
RIVERSIDE
THIRD
2ND
W. 2ND. ST.
CITY HALL
HOSPITAL
COURT HOUSE
TO NEWPORT
4TH
COVINGTON AVE.
7
8
GOOD COUNSEL ELEM. SCH.
1ST DIST. ELEM. SCH.
LASALETTE ACADEMY HIGH SCH.
PERSHING
POST OFFICE
WASHINGTON
LICKING
9TH
10TH
ROBBINS
9
COVINGTON LATIN HIGH SCH.
BERRY ST.
BUSH
TO NEWPORT
TOLL BRIDGE
12TH
TREVOR ST
BISHOP HOWARD MEMORIAL SCH.
10
PLEASANT
TO NEWPORT
LINDEN GROVE CEMETERY
BYRD
MARTIN ST.
ST BENEDICT ELEM. SCH.
4TH DIST. ELEM. SCH.
OLIVER ST.
11
12
THOMAS ST.
5TH DISTRICT ELEM. SCH.
6TH DISTRICT ELEM. SCH.
RADIO TOWER
71
75
CRESCENT
LINDEN
JEFFERSON
MONROE
RUSSELL
FLOOD

Figure 46. Truck Area Route Maps for Team II Mon-Thur Collection, Alternative III-A



7
8
9
10
11
12
II
T-F
CAMPBELL
KENTON
LICKING
TO NEWPORT
ST. ELIZABETHS HOSPITAL
HOLMES HIGH SCH.
HOLY CROSS ELEM. & HIGH SCHOOL
ST AUGUSTINE ELEM. SCH.
5TH DISTRICT ELEM. SCH.
6TH DISTRICT ELEM. SCH.
8TH DIST. ELEM. SCH.
CEM.
SOUTHERN AVE.

Figure 47. Truck Area Route Maps for Team II Tue-Fri Collection, Alternative III-A

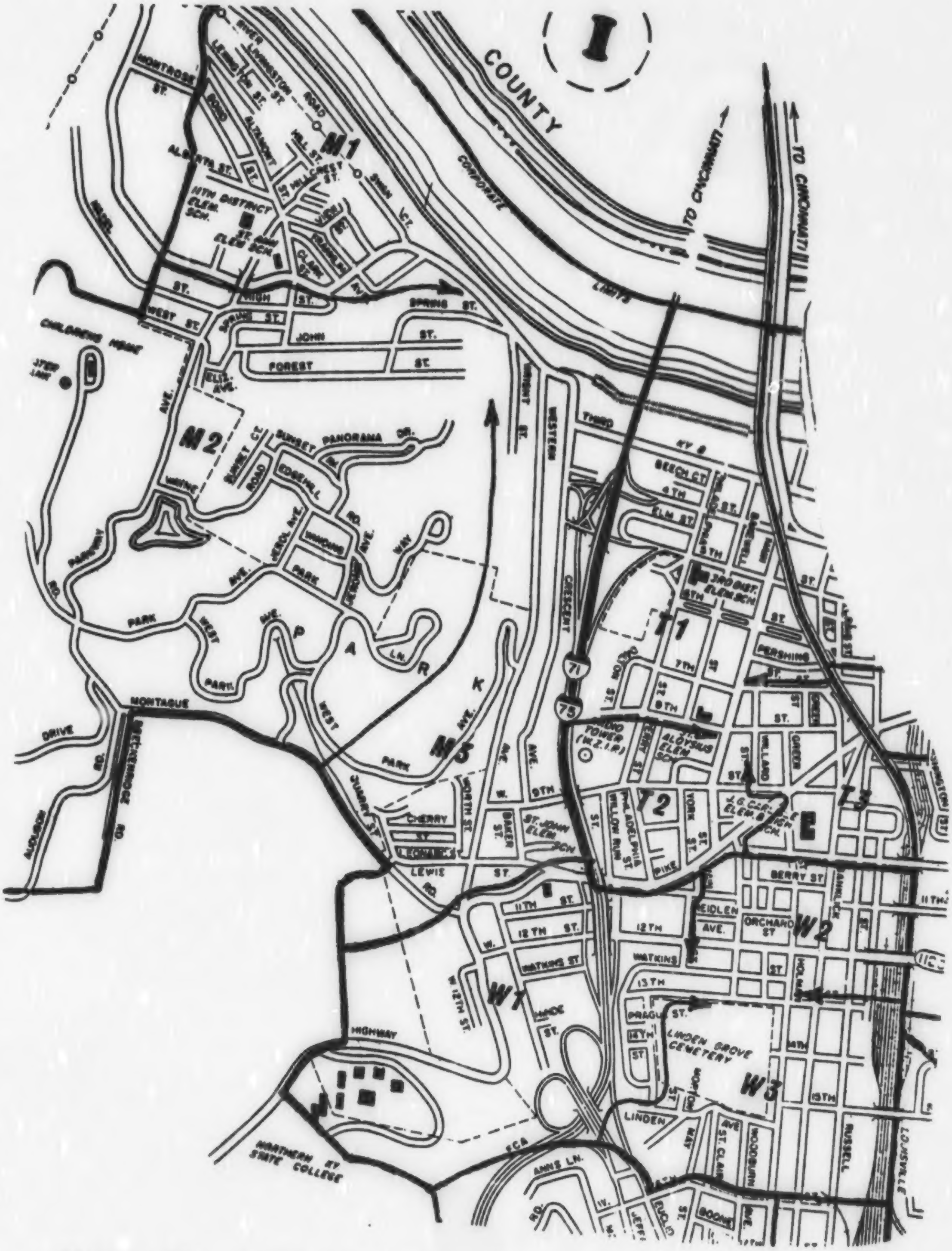


Figure 48. Truck Area Route Maps for Team I Mon-Tue-Wed Collection, Alternative IV

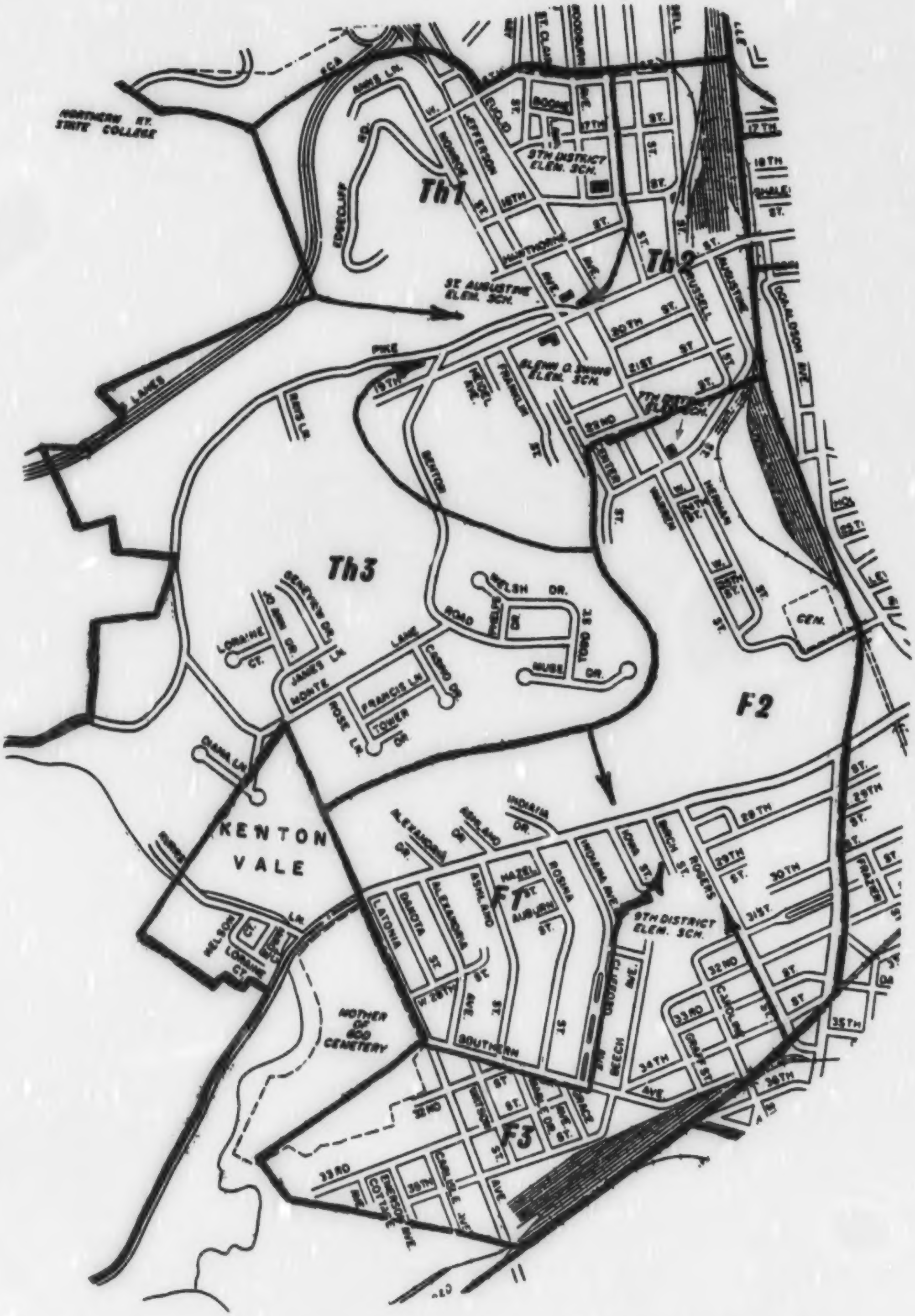

Th1
Th2
Th3
F1
F2
F3
NORTHERN KY. STATE COLLEGE
ST. AUGUSTINE ELEM. SCH.
5TH DISTRICT ELEM. SCH.
GLENN O. SWING ELEM. SCH.
KENTON VALE
MOTHER OF GOD CEMETERY
CEM.
PIKE
HAWTHORNE
JEFFERSON
EUCLID
RUSSELL
AUGUSTINE
DONALDSON AVE.
BENTON
WELSH DR.
HUGE DR.
FRANCIS LN.
TOWER DR.
JAMES LN.
MONTE
ROSE LN.
LORRAINE CT.
DIANA LN.
INDIANA DR.
ALEXANDRIA
ASHLAND
HAZEL
ROSINA
AUBURN
INDIANA AVE.
IOWA ST.
BIRCH ST.
ROGERS
LATONIA
DAKOTA
SOUTHERN
BEECH
CLIFFORD
20TH ST.
21ST ST.
22ND
29TH
30TH
31ST
32ND
33RD
34TH
35TH
36TH
NELSON

Figure 49. Truck Area Route Maps for Team I Thur-Fri Collection, Alternative IV

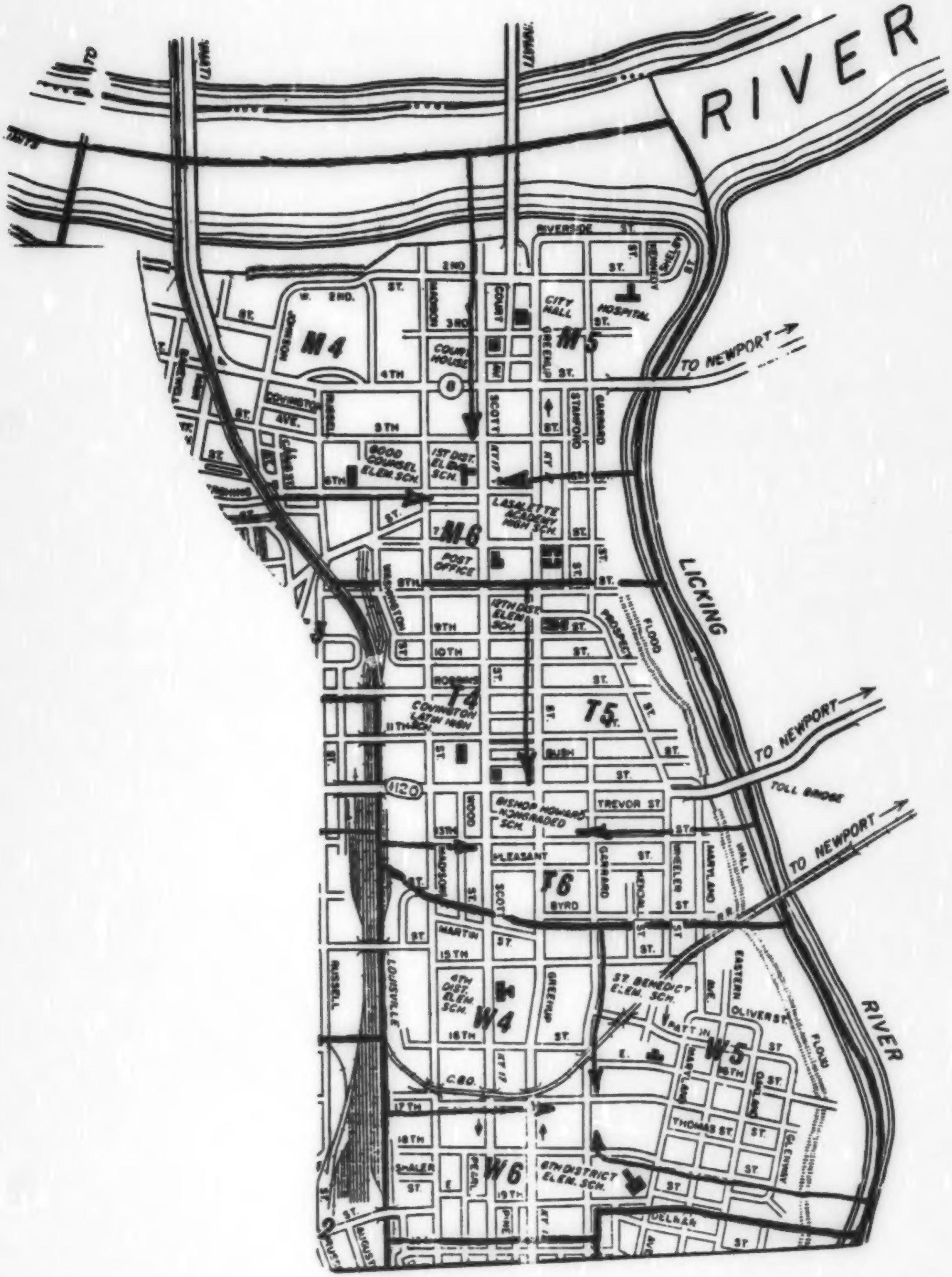

RIVER
RIVERSIDE ST.
CITY HALL
HOSPITAL
COURT HOUSE
M4
M5
M6
TO NEWPORT
GOOD COUNSEL ELEM. SCH.
1ST DIST. ELEM. SCH.
LASALETTE ACADEMY HIGH SCH.
POST OFFICE
12TH DIST. ELEM. SCH.
LICKING
COVINGTON LATIN HIGH SCH.
T4
T5
TO NEWPORT
TOLL BRIDGE
BISHOP HOWARD NONGRADED SCH.
TREVOR ST
PLEASANT
T6
BYRD
TO NEWPORT
4TH DIST. ELEM. SCH.
W4
ST. BENEDICT ELEM. SCH.
W5
C.&O.
THOMAS ST
W6
6TH DISTRICT ELEM. SCH.
RIVER
SCOTT
MADISON
GREENUP
GARRARD
STAMFORD
WASHINGTON
RUSSELL
LOUISVILLE
WOOD
WHEELER ST
MARYLAND
EASTERN
OLIVER ST
FLOOD
PROSPECT
BUSH
ROBBINS
MARTIN
SHALER
PEARL
PIKE
DELAXA
AUGUSTINE
1120

Figure 50. Truck Area Route Maps for Team II Mon-Tue-Wed Collection, Alternative IV

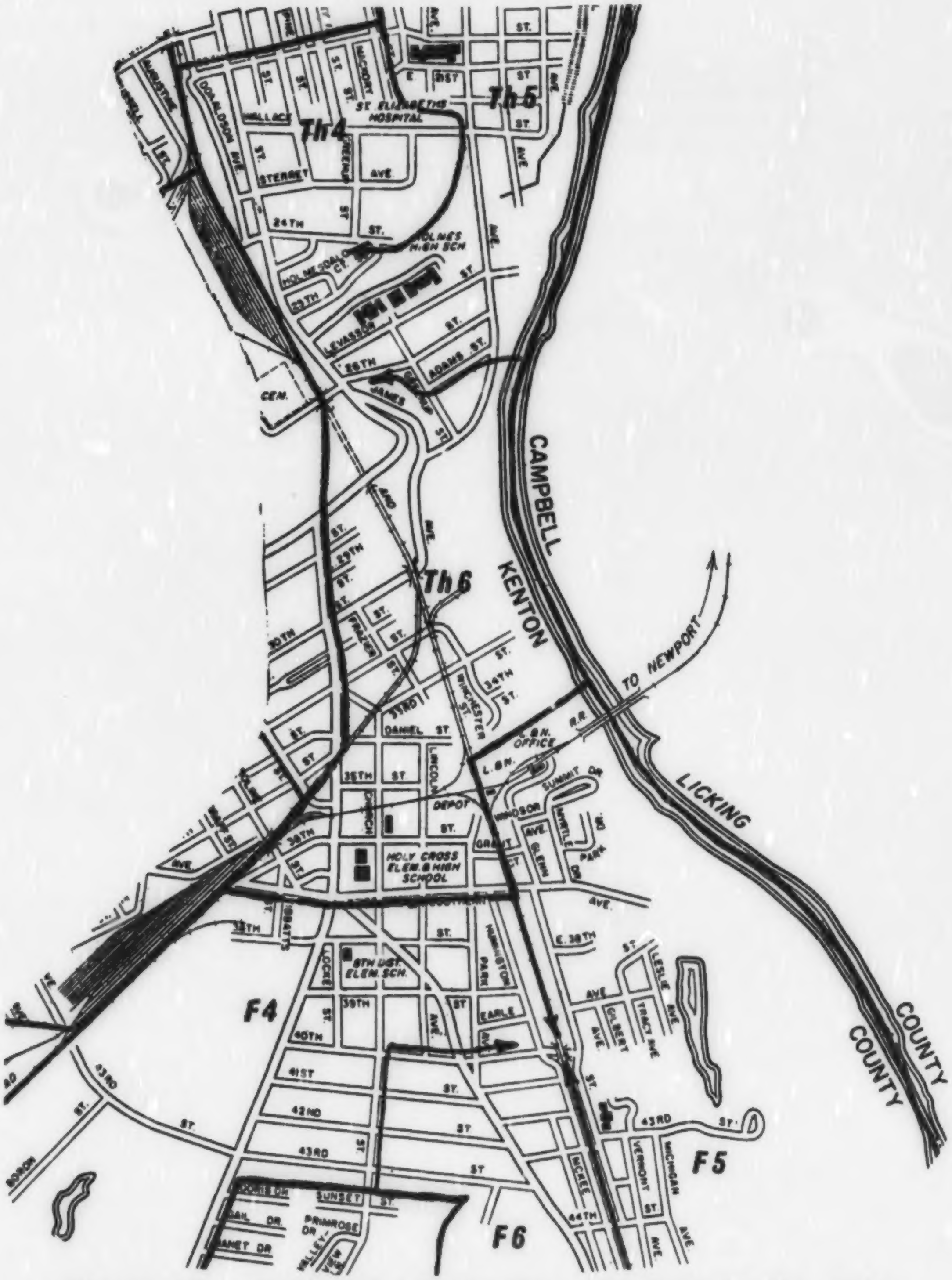

Th4
Th5
Th6
F4
F5
F6
ST. ELIZABETHS HOSPITAL
HOLMES HIGH SCH
HOLY CROSS ELEM. & HIGH SCHOOL
8TH DIST. ELEM. SCH.
L.&N. OFFICE
DEPOT
CEM.
TO NEWPORT
CAMPBELL
KENTON
LICKING
COUNTY
COUNTY
WALLACE
STERRET
AVE.
24TH
ST.
LEVASSOR
ADAMS ST.
JAMES
WINCHESTER ST.
DANIEL ST
33RD
35TH
36TH
38TH
39TH
40TH
41ST
42ND
43RD
44TH
E. 38TH
SUNSET
PRIMROSE
SUMMIT DR
WINDSOR
GRANT
GLENN
PARK
LESLIE
TRACY AVE
GILBERT
VERMONT
MICHIGAN
EARLE
HUNTINGTON

Figure 51. Truck Area Route Maps for Team II Thur-Fri Collection, Alternative IV

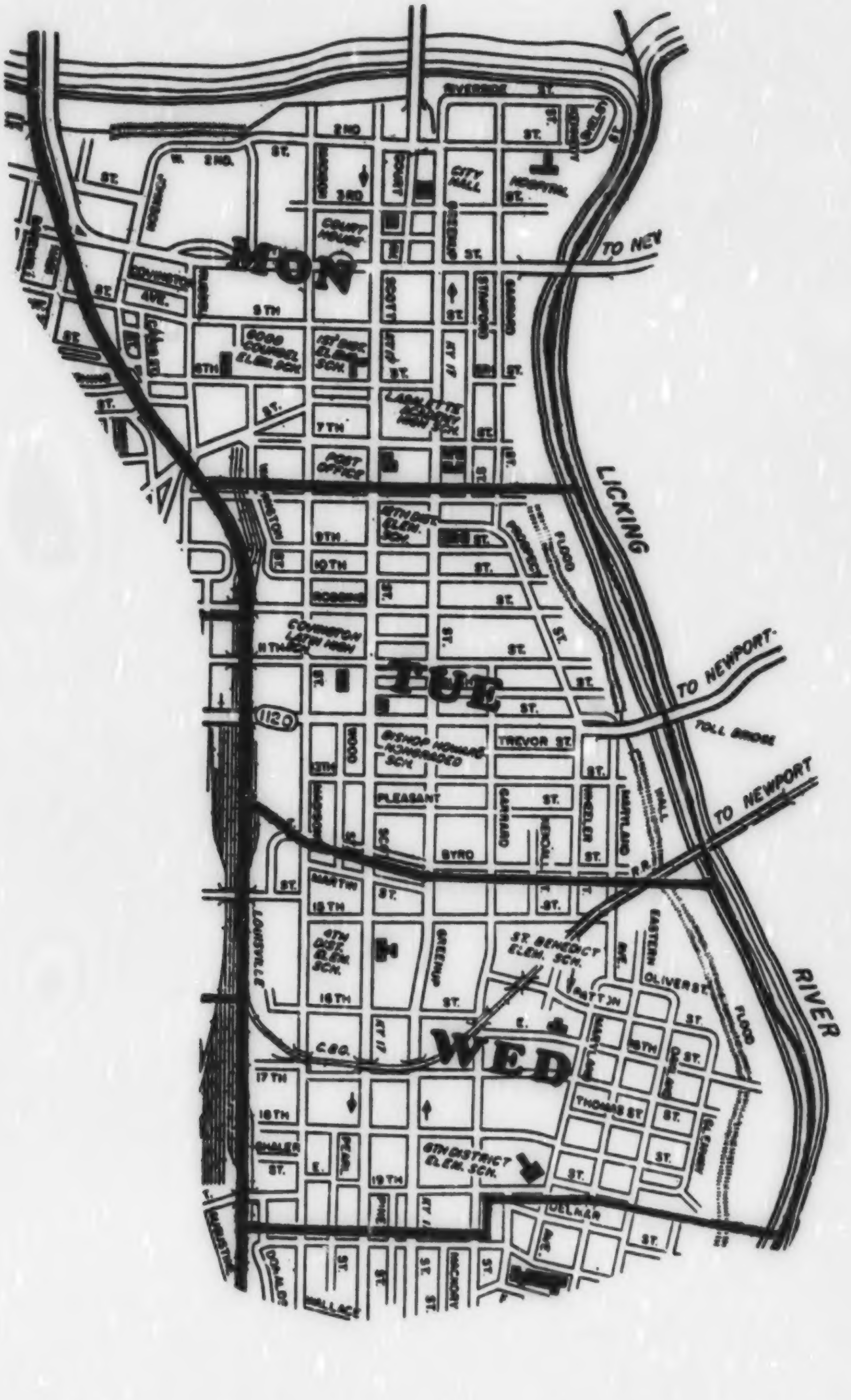

MON
TUE
WED
RIVERSIDE ST.
2ND
W. 2ND. ST.
3RD
CITY HALL
HOSPITAL
COURT
COURT HOUSE
COVINGTON AVE.
TO NEW
SCOTT
STAMFORD
GREENUP
5TH
GOOD COUNSEL ELEM. SCH.
1ST DIST. ELEM. SCH.
6TH
LASALETTE ACADEMY HIGH SCH.
7TH
POST OFFICE
WASHINGTON
9TH
10TH
ROBBINS
6TH DIST. ELEM. SCH.
PROSPECT
FLOOD
LICKING
COVINGTON LATIN HIGH SCH.
11TH
1120
TO NEWPORT
TOLL BRIDGE
TREVOR ST.
WOOD
BISHOP HOWARD NONGRADED SCH.
12TH
PLEASANT
GARRARD
MARYLAND
WALL
TO NEWPORT
BYRD
R.R.
MARTIN ST.
15TH
LOUISVILLE
4TH DIST. ELEM. SCH.
GREENUP
ST. BENEDICT ELEM. SCH.
EASTERN
OLIVER ST.
PATTON
16TH
C.&O.
KY 17
FLOOD
RIVER
17TH
18TH
THOMAS ST.
SHALER
PEARL
6TH DISTRICT ELEM. SCH.
19TH
PINE
DELMAR
HICKORY
WALLACE

Figure 52. Example Citizen Notification Map for Mon-Tue-Wed Collection, Alternative IV

CONCLUSIONS

To deal with changing constraints and multiple service objectives effectively, municipal management must be able to develop options for action. In providing waste collection services particularly, it is important that multiple alternatives be available and that the impact of each alternative be predicted prior to possible implementation. This flexibility is provided by the ability of accurately computing work content through the application of work measurement and detailed field data.

Both implementations were successful. The first implementation realized approximate savings at an annual rate of $113,000 while retaining twice-a-week frequency. The second implementation providing once-a-week collection realized an additional $112,000 annual savings ($225,000 total, 38 percent of original budget). The quality of service was consistently maintained or improved during both implementations. Prior to the first implementation, Covington had no incentive program. Both alternatives included a time incentive, and provided the technical basis for a monetary incentive. At this time, the City Commission has not yet elected to pursue a wage incentive program.

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9 APPENDIX

9.1 Sample Employee Preference Choice Form
9.2 Cover Letter for Employee Preference
9.3 Street Collection Data Form
9.4 Weigh Station Record Form
9.5 Partial Map of Covington With Block Identification Numbers
9.6 Computer Program for Work Sampling Values
9.7 Sample Computer Output of Automated Route Design
9.8 Sample Computer Output of Detail Route Design for Team I
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9.10 Sample Ordinance for Once-a-week Collection
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9.16 Driver Guidelines
9.17 Foreman's Activities

APPENDIX 9.1

Mr. ______________________________:

LABORERS

Thaddeus Avery
Archie Britton
Gary Carpenter
Chester Centers
Steven Findley
Thomas Griffin
William Hall
Jerry Harris
Billy Hitch
Richard Hughes
Robert Humphrey Jr.
Michael Irwin
Peter Jaquish
Steven Klein
Phillip Kraus
William Landrum
James Maddox
Arthur Marks
Charles Menke
William Miller
Maurice Mitchell
Fred Penick

Please write the first and last names of five laborers you want to work with. Please list five names only, no more and no less.

____
____
____
____
____

Please write the first and last names of five laborers you do not want to work with. Please list five names only, no more and no less.

____
____
____
____
____

Ronald Powers
Michael Rassche
Gerald Speakes
Robert Tabb
Jack Thomas
Michael Van Huss

APPENDIX 9.2

Mr.________________________:

As you know, Covington is trying to improve waste collection operations.

Permanent collection crews are being set up so that you will be able to work with the same people every day, as long as no one is absent.

Each truck crew will be made up of one Driver and two Laborers. Four of these crews will work together as a team to pick up each day's routes.

Since you will be working with the same people every day, it is very important that you work with the men you like and get along with.

The Local Union has agreed to help in finding out who you want to work with. On the next page is an alphabetical list of the Laborers. Please pick five Laborers you want to work with and five Laborers you don't want to work with. Write your choices on the next page.

Every effort will be made to put you on a crew and team with the men you want to work with, but every man may not get his first choices. This can happen if nearly everyone chooses the same men.

Please do not show your list to anyone else, just fold the paper and put it in the box. The only people who will see the list will be those who set up the crews and teams. Thank you.

APPENDIX 9.3

CITY OF COVINGTON
DEPARTMENT OF PUBLIC WORKS

STREET COLLECTION DATA

Day: M T W H F

Date: ____________

Street ________________________

From ______________ To ______________

Width: 2 cars
3 cars
4 cars
more than 4

	Parking (L) No Parking				Parking (R) No Parking			
Comments: (Note any delays or deviations from normal collection, e.g., driver helping, cans not at curb, truck backing, etc.)	Bags	Cans	Equiv. Cans	Stop No.	Bags	Cans	Equiv. Cans	Time/Mileage
				1				
				2				
				3				
				4				
				5				
				6				
				7				
				8				
				9				
				10				
				11				
				12				
				13				
				14				
				15				
				16				
				17				

APPENDIX 9.4

CITY OF COVINGTON
DEPARTMENT OF PUBLIC WORKS

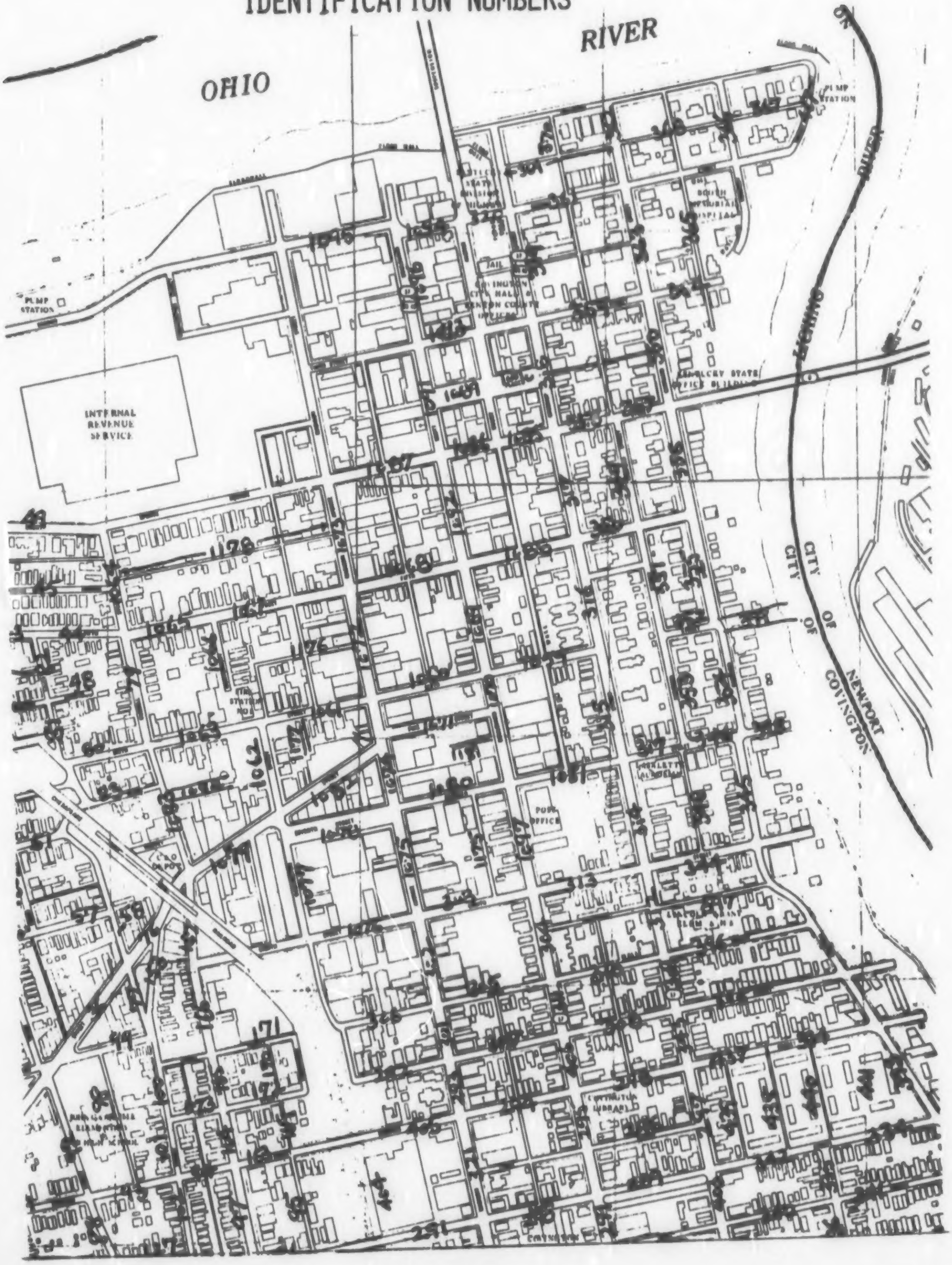
WEIGH STATION RECORD

Day: M T W H F

Date: ____________

Truck Number	Time	Gross Weight	Pavement	
			Dry	Wet

APPENDIX 9.5 PARTIAL MAP OF COVINGTON WITH BLOCK IDENTIFICATION NUMBERS


OHIO
RIVER
LICKING RIVER
PUMP STATION
PUMP STATION
INTERNAL REVENUE SERVICE
JAIL
COVINGTON CITY HALL & KENTON COUNTY OFFICES
KENTUCKY STATE OFFICE BUILDING
POST OFFICE
CITY OF COVINGTON
CITY OF NEWPORT
DEPOT
COVINGTON LIBRARY

APPENDIX 9.6 COMPUTER PROGRAM FOR WORK SAMPLING VALUES

```
$JOB    WORKSAMP    C51CYY HUMPHREYS/SHELL
C BASIC WORK SAMPLING STATISTICS
      INTEGER AREA.ACTIV
      DIMENSION AREA(1077).MAN(1077).ACTIV(1077)
      DIMENSION ACT(17).PERT(17).PERA(17).PERB(17)
      DIMENSION STATT(17).STATA(17).STATB(17)
      DIMENSION AREAB(4)
      DATA AREAB(1)/' NA '/.AREAB(2)/'SRES'/.AREAB(3)/'MRES'/.
     1AREAB(4)/'CTWN'/
      DATA ACT(1)/'NA '/.ACT(2)/'ECC'/.ACT(3)/'ECB'/.ACT(4)/'ECE'/.ACT(5
     2)/'WCC'/.ACT(6)/'WCB'/.ACT(7)/'WCE'/.ACT(8)/'WEC'/.ACT(9)/'WEB'/.
     3ACT(10)/'WEF'/.ACT(11)/'WK '/.ACT(12)/'RD '/.ACT(13)/'PK '/.ACT(14
     4)/'SP '/.ACT(15)/'BK '/.ACT(16)/'LT '/.ACT(17)/'BRK'/
      DO 1 NUM=1.1077
      READ(5.500)AREA(NUM).MAN(NUM).ACTIV(NUM)
  500 FORMAT(17XI1.6XI1.I2)
      IF(AREA(NUM).EQ.0)GO TO 31
    1 CONTINUE
   31 NUM=NUM-1
      FNUM=NUM
      DO 10 I=1.NUM
   10 AREA(I)=AREA(I)+1
      DO 2 K1=1.4
C  INITIALIZE COUNTERS
      SUM=0.
      DO 11 I=1.17
      STATT(I)=0.
      STATA(I)=0.
   11 STATB(I)=0.
      CNTA=0.
      CNTB=0.
C  GATHER STATISTICS
      DO 3 J=1.NUM
      IF(AREA(J).NE.K1)GO TO 3
      SUM=SUM+1.
```

APPENDIX 9.6, CONTINUED

```
      I=ACTIV(J)+1
      STATT(I)=STATT(I)+1.
      IF(MAN(J).EQ.1)STATA(I)=STATA(I)+1.
      IF(MAN(J).EQ.1)CNTA=CNTA+1.
      IF(MAN(J).EQ.2)STATB(I)=STATB(I)+1.
      IF(MAN(J).EQ.2)CNTB=CNTB+1.
    3 CONTINUE
C  CALCULATE PERCENT OF OBSERVATIONS FOR EACH ACTIVITY
      IF(SUM.EQ.0.)GO TO 2
      DO 13 K=1,17
      PERT(K)=STATT(K)*100./SUM
      PERA(K)=STATA(K)*100./CNTA
   13 PERB(K)=STATB(K)*100./CNTB
C  WRITE STATISTICS
      WRITE(6,60)AREAB(K1)
   60 FORMAT(1H1,30X,'AREA=',A4)
      WRITE(6,61)
   61 FORMAT(1H0,25X,'ACTIVITY OCCURENCE',/,3X,'(NUMBER OF TIMES ACTIVI
     2TY OBSERVED/TOTAL NUMBER OF OBSERVATIONS)')
      WRITE(6,62)

   62 FORMAT(1H0,17X,'ACTIVITY     TOTAL     MAN A     MAN B')
      DO 14 L=1,17
      WRITE(6,601)ACT(L),PERT(L),PERA(L),PERB(L)
  601 FORMAT(1H0,20X,A3,7X,F6.3,4X,F6.3,4X,F6.3)
   14 CONTINUE
    2 CONTINUE
      STOP
      END

$ENTRY
```

APPENDIX 9.7 SAMPLE COMPUTER OUTPUT OF AUTOMATED ROUTE DESIGN

```
RUN

ONEDAY      15:06   03/23/75  SUNDAY


 MAP DISTANCE ?
?21

 WHICH SIDE DO YOU WANT TO WORK WITH
    LEFT = 1
   RIGHT = 2

?2

 WANT TO CHANGE THE STARTING ID #
?0

  LOAD # 1    WEIGHT=10544 LB   TIME 10:54   LAST ID #   360
  LOAD # 2    WEIGHT= 9849 LB   TIME  1:57   LAST ID #    44


***************************************************************


 MAP DISTANCE ?
?20

  LOAD # 1    WEIGHT=10448 LB   TIME 10:43   LAST ID #  1088
  LOAD # 2    WEIGHT= 9902 LB   TIME  2: 5   LAST ID #   351


***************************************************************


 MAP DISTANCE ?
?19

  LOAD # 1    WEIGHT= 9666 LB   TIME 10:40   LAST ID #   345
  LOAD # 2    WEIGHT=10162 LB   TIME  1:48   LAST ID #   344
  LOAD # 3    WEIGHT= 2357 LB   TIME  2:59   LAST ID #   312


***************************************************************
```

```
 MAP DISTANCE ?
?18

  LOAD # 1   WEIGHT=10011 LB  TIME 10:33  LAST ID #   308
  LOAD # 2   WEIGHT= 9360 LB  TIME  1:29  LAST ID #   439
  LOAD # 3   WEIGHT= 4382 LB  TIME  3: 0  LAST ID #   334


************************************************************


 MAP DISTANCE ?
?17

  LOAD # 1   WEIGHT= 9476 LB  TIME 10:33  LAST ID #   323
  LOAD # 2   WEIGHT= 9593 LB  TIME  1:24  LAST ID #   329
  LOAD # 3   WEIGHT= 4544 LB  TIME  2:56  LAST ID #   287


************************************************************


 MAP DISTANCE ?
?16

  LOAD # 1   WEIGHT= 9593 LB  TIME 10:18  LAST ID #   328
  LOAD # 2   WEIGHT=10203 LB  TIME  1:14  LAST ID #   448
  LOAD # 3   WEIGHT= 6290 LB  TIME  2:57  LAST ID #   414


************************************************************


 MAP DISTANCE ?
?15

  LOAD # 1   WEIGHT= 9473 LB  TIME 10:24  LAST ID #   451
  LOAD # 2   WEIGHT= 9897 LB  TIME  1:11  LAST ID #  1198
  LOAD # 3   WEIGHT= 6910 LB  TIME  3: 2  LAST ID #   461


************************************************************
```

```
 MAP DISTANCE ?
?14

  LOAD # 1     WEIGHT= 9858 LB   TIME 10:14   LAST ID #    510
  LOAD # 2     WEIGHT=10234 LB   TIME 12:57   LAST ID #    465
  LOAD # 3     WEIGHT= 7622 LB   TIME  2:55   LAST ID #    480


************************************************************


 MAP DISTANCE ?
?15

  LOAD # 1     WEIGHT= 9869 LB   TIME 10:23   LAST ID #    597
  LOAD # 2     WEIGHT= 9627 LB   TIME  1:12   LAST ID #    570
  LOAD # 3     WEIGHT= 6701 LB   TIME  2:59   LAST ID #    558


************************************************************


 MAP DISTANCE ?
?13

  LOAD # 1     WEIGHT= 9757 LB   TIME 10:23   LAST ID #    535
  LOAD # 2     WEIGHT= 9513 LB   TIME 12:57   LAST ID #    578
  LOAD # 3     WEIGHT= 7670 LB   TIME  2:54   LAST ID #    566


************************************************************


 MAP DISTANCE ?
?10

  LOAD # 1     WEIGHT=10485 LB   TIME 10:20   LAST ID #    714
  LOAD # 2     WEIGHT= 9460 LB   TIME 12:58   LAST ID #    707
  LOAD # 3     WEIGHT= 7199 LB   TIME  2:55   LAST ID #    694


************************************************************
```

APPENDIX 9.8 SAMPLE COMPUTER OUTPUT OF DETAIL ROUTE DESIGN

```
 PLEASE PUNCH THE ESTIMATED MAP-DISTANCE IN INCHES
 FROM THE GARAGE TO THE FIRST STOP
?9

 TIME AT THE FIRST STOP IS  8: 6

 ALLOWING 8.0 MINS. FOR FUELLING
 CLOCK TIME IS  8:14


 NOW GO AHEAD AND START PUNCHING THE ID'S

 ID #
?790

            16.7      1565      8:31
 ID #
?791

            37.3      3468      8:52
 ID #
?789

            55.4      5187      9:10
 ID #
?788

            68.6      6508      9:23
 ID #
?433

            77.6      7313      9:32
 ID #
?786

            84.2      7944      9:39
 ID #
?787

            86.5      8124      9:41
 ID #
?785

            88.9      8325      9:43
 ID #
?792

           103.9      9503      9:58
```

```
   **** THE LOAD IS FULL ****
PLEASE ENTER THE DISTANCE IN MAP-INCHES FROM THE ROUTE TO
THE LAND-FILL

?8

    THIS LOAD WEIGHS   9503 POUNDS
    TOTAL WEIGHT IN THE ROUTE =  9503 POUNDS
    TOTAL TIME IN COLLECTION = 103.9 MINS.
    TIME SPENT IN TRAVELLING = 11.4 MINS.
    TOTAL COLLECTION TIME IN THE ROUTE =  103 MINS.
    TIME SPENT AT THE LAND-FILL = 10.0 MINS.
    CLOCK TIME IS 10:19
 ID #
?793
           132.2      2457     10:47
 ID #
?782
           136.3      2861     10:51
 ID #
?783
           141.5      3389     10:56
 ID #
?847
           147.1      3845     11: 2
 ID #
?781
           153.5      4457     11: 8
 ID #
?780
           156.7      4797     11:11
 ID #
?784
           158.7      4947     11:13
 ID #
?817
           180.1      6580     11:34
 ID #
?779
           195.8      8110     11:50
 ID #
?866
```

```
          205.9     9101     12: C
NOW IT IS TIME FOR THE LUNCH. WE SHALL
ADVANCE THE CLOCK BY 30 MINUTES.


ALLOWING 8.0 MINS. FOR FUELLING
CLOCK TIME IS 12:38

   **** THE LOAD IS FULL ****
PLEASE ENTER THE DISTANCE IN MAP-INCHES FROM THE ROUTE TO
THE LAND-FILL

?8

   THIS LOAD WEIGHS   9101 POUNDS
   TOTAL WEIGHT IN THE ROUTE = 18604 POUNDS
   TOTAL TIME IN COLLECTION = 205.9 MINS.
   TIME SPENT IN TRAVELLING = 11.4 MINS.
   TOTAL COLLECTION TIME IN THE ROUTE =  308 MINS.
   TIME SPENT AT THE LAND-FILL = 10.0 MINS.
   CLOCK TIME IS 12:59
 ID #
?864

          210.2      307      1: 3
 ID #
?865

          212.1      399      1: 5
 ID #
?863

          222.6     1346      1:16
 ID #
?862

          233.1     2293      1:27
 ID #
?841

          247.6     3596      1:41
 ID #
?840

          254.0     4203      1:47
 ID #
?822

          261.1     4798      1:54
 ID #
?821
```

```
          267.8       5101       2: 1

     PLEASE NOTE THAT THE QUITTING TIME IS APPROACHING
     PLEASE PRINT THE MAP DISTANCE IN INCHES TO THE LANDFILL

?6

     ALSO NOTE THAT IT WILL TAKE ABOUT  4.3 MINS
     TO GO TO THE LANDFILL AND 10.0 MINS
     AT THE LAND-FILL. NOW YOU CAN FINISH THE LOAD
     BY PUNCHING A DUMMY ID# = 7777
 ID #
?904

    TIME  2: 6
          272.6       5342       2: 6
 ID #
?902

    TIME  2: 7
          273.6       5387       2: 7
 ID #
?688
    TIME  2:16
          283.1       5993       2:16
 ID #
?901

    TIME  2:18
          285.4       6188       2:18
 ID #
?735

    TIME  2:20
          287.5       6368       2:20
 ID #
?737

    TIME  2:36
          303.5       7624       2:36
 ID #
?7777

    **** THE LOAD IS FULL ****
 PLEASE ENTER THE DISTANCE IN MAP-INCHES FROM THE ROUTE TO
 THE LAND-FILL

 ?6
```

```
   THIS LOAD WEIGHS    7624 POUNDS
   TOTAL WEIGHT IN THE ROUTE = 26228 POUNDS
   TOTAL TIME IN COLLECTION = 303.5 MINS.
   TIME SPENT IN TRAVELLING =   4.3 MINS.
   TOTAL COLLECTION TIME IN THE ROUTE =  611 MINS.
   TIME SPENT AT THE LAND-FILL = 10.0 MINS.
   CLOCK TIME IS  2:50



   END OF THE ROUTE
TOTAL TIME=  303.5
TOTAL WEIGHT=    26228 POUNDS
 NO. OF LOADS =  3


    THE FOLLOWING ID'S HAVE BEEN INCLUDED IN THE ROUTE

     433     688     735     737     779     780     781     782     783     784
     785     786     787     788     789     790     791     792     793     817
     821     822     840     841     847     862     863     864     865     866
     901     902       0
 DO YOU WANT TO DESIGN A NEW ROUTE
?0

STOP
TIME 3 SECS.

OFF
OFF AT 18:56
PROC. TIME...    16 SEC.
TERM. TIME...  246 MIN.
```

APPENDIX 9.9, SAMPLE COMPUTER OUTPUT OF DETAIL ROUTE DESIGN

```
ON AT 19:57   03/23/75  SUNDAY  LINE 1
USER NUMBER,PASSWORD--BUS001,BUSMGT
READY

LOAD NEWMOD1
READY

RUN

NEWMOD1     19:59   03/23/75  SUNDAY


DO YOU WANT ABBREVIATED OUTPUT?
    YES=1
     NO=0
?1

 IS IT A NEW ROUTE?
    YES=1
     NO=0
?1

 PLEASE PUNCH THE ESTIMATED MAP-DISTANCE IN INCHES
 FROM THE GARAGE TO THE FIRST STOP
?21

 TIME AT THE FIRST STOP IS  8:15

 ALLOWING 8.0 MINS. FOR FUELLING
 CLOCK TIME IS  8:23


 NOW GO AHEAD AND START PUNCHING THE ID'S

 ID #
?367

             5.0      436     8:28
 ID #
?366

             7.4      653     8:30
 ID #
?467

            14.0     1332     8:37
 ID #
?368
```

```
             29.1      2687      8:52
  ID #
 ?370

             30.6      2778      8:54
  ID #
 ?369

             36.8      3370      9: 0
  ID #
 ?361

             38.8      3485      9: 2
  ID #
 ?320

             39.9      3560      9: 3
  ID #
 ?1094

             47.7      4087      9:11
  ID #
 ?319

             54.9      4583      9:18
  ID #
 ?363

             61.3      5182      9:24
  ID #
 ?365

             64.0      5377      9;27
  ID #
 ?364

             68.2      5798      9:31
  ID #
 ?359

             76.1      6537      9:39
  ID #
 ?1093

             78.1      6729      9:41
  ID #
 ?1089

             82.5      7122      9:45
  ID #
 ?1090
```

```
          83.0     7152     9:45
 ID #
?318

          94.3     8124     9:56
 ID #
?360
         109.1     9413    10:11
   **** THE LOAD IS FULL ****
 PLEASE ENTER THE DISTANCE IN MAP-INCHES FROM THE ROUTE TO
 THE LAND-FILL

?20

   THIS LOAD WEIGHS   9413 POUNDS
   TOTAL WEIGHT IN THE ROUTE =  9413 POUNDS
   TOTAL TIME IN COLLECTION = 109.1 MINS.
   TIME SPENT IN TRAVELLING = 28.4 MINS.
   TOTAL COLLECTION TIME IN THE ROUTE =  109 MINS.
   TIME SPENT AT THE LAND-FILL = 10.0 MINS.
   CLOCK TIME IS 10:49

 ID #
?1096

         126.4     1195    11: 6
 ID #
?1091

         130.0     1420    11:10
 ID #
?1086

         132.8     1631    11:13
 ID #
?1085

         136.1     1948    11:16
 ID #
?358

         138.6     2135    11:19
 ID #
?357

         141.8     2383    11:22
 ID #
?356

         148.3     2859    11:29
 ID #
```

```
          154.8      3482     11:35
 ID #
?317

          164.8      4279     11:45
 ID #
?1092

          175.4      5082     11:56
 ID #
?1088

          190.7      6459     12:11
 NOW IT IS TIME FOR THE LUNCH. WE SHALL
 ADVANCE THE CLOCK BY 30 MINUTES.

 ID #
?350

          194.1      6805     12:44
 ID #
?355

          203.1      7680     12:53
 ID #
?351

          222.5      9802      1:12

 ALLOWING 8.0 MINS. FOR FUELLING
 CLOCK TIME IS  1:20

    **** THE LOAD IS FULL ****
 PLEASE ENTER THE DISTANCE IN MAP-INCHES FROM THE ROUTE TO
 THE LAND-FILL

?19

    THIS LOAD WEIGHS   9802 POUNDS
    TOTAL WEIGHT IN THE ROUTE = 19215 POUNDS
    TOTAL TIME IN COLLECTION = 222.5 MINS.
    TIME SPENT IN TRAVELLING = 27.0 MINS.
    TOTAL COLLECTION TIME IN THE ROUTE =  331 MINS.
    TIME SPENT AT THE LAND-FILL = 10.0 MINS.
    CLOCK TIME IS  1:56
```

APPENDIX 9.10 SAMPLE ORDINANCE FOR ONCE-A-WEEK COLLECTION

COMMISSIONERS' ORDINANCE NO. ____

AN ORDINANCE REGULATING THE CONTAINERIZATION AND COLLECTION OF GARBAGE, TRASH, GARDEN TRASH, AND CERTAIN NON-COMBUSTIBLE REFUSE IN THE CITY OF COVINGTON, KENTUCKY: PRESCRIBING CONDITIONS FOR CONTAINERIZATION AND FOR COLLECTION BY THE PUBLIC WORKS DEPARTMENT.

WHEREAS, the City of Covington will implement a new collection system including new route areas, uniform collection schedules, revised collection location and storage requirements, an initiative program for waste collection employees, and the addition of large item special pickup service.

NOW, THEREFORE
BE IT ORDAINED BY THE BOARD OF COMMISSIONERS OF THE CITY OF COVINGTON, KENTON COUNTY, KENTUCKY:

Section 1

DEFINITIONS

Definitions for the following are as stated in Commissioners' Ordinance No. 0-49-72: GARBAGE, TRASH, NON-COMBUSTIBLE REFUSE, GARDEN TRASH, INDUSTRIAL PROCESSING WASTES, and PERSON.

In addition, for the purpose of this ordinance, the following are defined:

HEAVY USER: A person whose setout on a scheduled collection day exceeds forty (40) bags, or twenty (20) cans or their equivalent as defined below.

GARBAGE AND TRASH CONTAINERS:

1) CAN: A metal or plastic container normally sold as a "garbage can" with capacity between ten (10) and thirty (30) gallons with handles suitable for lifting. Cans containing garbage must have lids and be watertight.

2) BAG: A plastic or paper container normally sold as a "trash bag."

3) HEAVY USER CONTAINER: A steel container, with lid, of up to two-cubic-yard capacity that is designed for rear loading collection as specified by the Department of Public Works.

UNEXCUSED ABSENTEEISM WITHOUT PAY:

Being absent for any part of a scheduled work day for reasons other than absences allowed with pay.

Section 2

INITIATIVE PROGRAM

New collection route areas shall be implemented during the month of August, 1973 that will provide a time initiative for waste collection personnel. The route areas shall be assigned to teams consisting of trucks, crews, and foremen, and each area shall be designed for an approximate six and one-half (6 1/2) hour work day, thus providing an average of one and one-half (1 1/2) hours daily time initiative for team members. No member of a team shall conclude his work day without permission of the team foreman until that team's assigned area has been collected. The collection route areas shall be reviewed periodically to adjust for variations in work content due to changing characteristics of the City in order to maintain the time initiative program.

For the initiative program to operate successfully absenteeism without pay shall be considered excessive and shall constitute inefficiency as outlined in KRS 90.360 when any employee accumulates three (3) such occurrences during a calendar month.

Section 3

COLLECTION

FREQUENCY

All persons within the City of Covington shall be provided with once-a-week scheduled collection service and large item pickup service on a call basis as described in Section 5. Additional collections shall be provided on request to an approval by the Superintendent of Public Works according to the following schedules:

Heavy User Containers:

Additional Pickups	Monthly Charge	
Per Week	1st Container	Each Additional Container Dumped
1	\$20.00	\$3.00
2	\$30.00	\$6.00

Heavy User Containers (Continued)

Additional Pickups Per Week	Monthly Charge 1st Container	Monthly Charge Each Additional Container Dumped
3	$40.00	$9.00
4	$50.00	$12.00

Bags, Cans, or their Equivalent:

Additional Pickups Per Week	Monthly Charge 1st 20 Cans/ Equiv./40 Bags	Monthly Charge Ea. Addt'l 20 Cans/Equiv./40 Bags
1	$20.00	$3.00
2	$30.00	$6.00
3	$40.00	$9.00
4	$50.00	$12.00

ALLEY COLLECTION:

Alley collection shall be provided where alleys permit adequate passage and clearance for collection and where requested by the majority of users concerned. Request shall be directed to the Superintendent of Public Works for his approval.

HEAVY USERS:

New heavy users shall provide heavy users containers for collection. New multiple family dwellings with five or more dwelling units shall provide heavy user containers for collection. Existing heavy users shall be encouraged to provide heavy user containers for collection wherever possible.

Section 4

CONTAINER REQUIREMENTS FOR COLLECTION

1) CAN: Maximum weight of a loaded can shall not exceed fifty (50) pounds.

2) BAG: Each bag shall be properly tied or otherwise secured at the top and shall be loaded so as to permit handling for collection without tearing.

3) OTHER: A non-containerized amount of trash or garden trash

not exceeding the volume and weight limits of a can shall be suitably bound, boxed, or packaged to permit handling for collection without coming apart.

4) LOCATION: Heavy user containers shall be located where they are readily accessible from the public right of way and shall be placed at the curb line or approved alley location on the scheduled collection day(s). In those cases where setout space is not available, the user shall provide setout upon arrival of the collection vehicle, so that City employees are not required to enter private property.

5) CONDITION OF CONTAINERS: All cans and heavy user containers shall be maintained in good condition and repair, and shall be subject to inspection at setout by waste collection personnel. Containers in unsatisfactory condition shall be marked as condemned by Public Works supervisory personnel, and, as a service to the user, shall be removed at its next setout.

Section 5

LARGE ITEM SPECIAL PICKUP SERVICE

Special two-man pickup service shall be provided on a "call" basis to persons desiring to dispose of individual items not exceeding two-hundred (200) pounds which cannot be collected by the regular collection vehicle, such as furniture, appliances, hardware, or other items approved by the Superintendent of Public Works. Persons desiring this service shall call the Public Works Department and give their name, address, and descriptions of item(s) to be collected. They will be advised when to set these items out. Items must be placed at the curbline or at approved alley location, so that City employees are not required to enter private property. Special pickup service does not apply to loose materials such as loose trash, loose garden trash, or industrial processing wastes.

APPENDIX 9.11, SAMPLE ORDINANCE FOR TWICE-A-WEEK COLLECTION

COMMISSIONERS' ORDINANCE NO._______

AN ORDINANCE REGULATING THE CONTAINERIZATION AND COLLECTION OF GARBAGE, TRASH, GARDEN TRASH, AND CERTAIN NON-CUMBUSTIBLE REFUSE IN THE CITY OF COVINGTON, KENTUCKY; PRESCRIBING CONDITIONS FOR CONTAINERIZATION AND FOR COLLECTION BY THE PUBLIC WORKS DEPARTMENT.

WHEREAS, the City of Covington will implement a new collection system including new route areas, uniform collection schedules, revised collection location and storage requirements, an initiative program for waste collection employees, and the addition of large item special pickup service.

NOW, THEREFORE,
BE IT ORDAINED BY THE BOARD OF COMMISSIONERS OF THE CITY OF COVINGTON, KENTON COUNTY, KENTUCKY:

Section 1

DEFINITIONS

Definitions for the following are as stated in Commissioners Ordinance No. 0-49-72: GARBAGE, TRASH, NON-COMBUSTIBLE REFUSE, GARDEN TRASH, INDUSTRIAL PROCESSING WASTES, and PERSON.

In addition, for the purpose of this ordinance, the following are defined:

HEAVY USER: A person whose setout on a scheduled collection day exceeds thirty (30) bags, or fifteen (15) cans or their equivalent as defined below.

GARBAGE AND TRASH CONTAINERS:

1) CAN: A metal or plastic container normally sold as a "garbage can" with capacity between ten (10) and thirty (30) gallons with handles suitable for lifting. Cans containing garbage must have lids and be water tight.

2) BAG: A plastic or paper container normally sold as a "trash bag".

3) HEAVY USER CONTAINER: A steel container, with lid, of up to two-cubic-yard capacity that is designed for rear loading collection as specified by the Department of Public Works.

UNEXCUSED ABSENTEEISM WITHOUT PAY:

Being absent for any part of a scheduled work day for reasons other than absences allowed with pay.

Section 2

INITIATIVE PROGRAM

New collection route areas shall be implemented that will provide a time initiative for waste collection personnel. The route areas shall be assigned to teams consisting of trucks, crews, and foremen, and each area shall be designed for an approximate six and one-half (6½) hour work day, thus providing an average of one and one-half (1½) hours daily time initiative for team members. No member of a team shall conclude his work day without permission of the team foreman until that team's assigned area has been collected. The collection route area shall be reviewed periodically to adjust for variations in work content due to changing characteristics of the City in order to maintain the time initiative program.

For the initiative program to operate successfully, absenteeism must be minimized. Unexcused absenteeism without pay shall be considered excessive and shall constitute inefficiency as outlined in KRS 90.360 when any employee accumulates three (3) such occurrences during a calendar month.

Section 3

COLLECTION

FREQUENCY:

All persons within the City of Covington shall be provided with twice-a-week scheduled collection service and large item pickup service on a call basis as described in Section 5. Additional collections shall be provided on request to and approval by the Superintendent of Public Works according to the following schedules:

HEAVY USER CONTAINERS:

Additional Pickups Per Week	Monthly Charge	
	1st Container	Each Additional Container Dumped
1	$30.00	$3.00
(if on Wed.)	10.00	1.00
2	40.00	6.00
3	50.00	9.00

BAGS, CANS, OR THEIR EQUIVALENT:

Additional Pickups Per Week	Monthly Charge	
	1st 15 Cans/ Equiv./30 Bags	Ea. Addt'l 15 Cans/Equiv./30 Bag
1	$30.00	$3.00
(if on Wed.)	10.00	1.00
2	40.00	6.00
3	50.00	9.00

ALLEY COLLECTION:

Alley collection shall be provided where alleys permit adequate passage and clearance for collection and where requested by the majority of users concerned. Requests shall be directed to the Superintendent of Public Works for his approval.

HEAVY USERS:

New heavy users shall provide heavy users containers for collection. New multiple family dwellings with five or more dwelling units shall provide heavy user containers for collection Existing heavy users shall be encouraged to provide heavy user containers for collection wherever possible.

Section 4

CONTAINER REQUIREMENTS FOR COLLECTION

1) CAN: Maximum weight of a loaded can shall not exceed fifty (50) pounds.

2) BAG: Each bag shall be properly tied or otherwise secured at the top and shall be loaded so as to permit handling for collection without tearing.

3) OTHER: A non-containerized amount of trash or garden trash not exceeding the volume and weight limits of a can shall be suitably bound, boxed, or packaged to permit handling for collection without coming apart.

4) LOCATION: Heavy user containers shall be located where they are readily accessible from the public right of way and shall be placed at the curb line or approved alley location on the scheduled collection days. In those cases where setout space is not available, the user shall provide setout upon arrival of the collection vehicle, so that City employees are not required to enter private property.

5) CONDITION OF CONTAINERS: All cans and heavy containers shall be maintained in good condition and repair, and shall be subject to inspection at setout by waste collection personnel. Containers in unsatisfactory condition shall be so marked by Public Works supervisory personnel, and, as a service to the user, shall be removed at its next setout.

Section 5

LARGE ITEM SPECIAL PICKUP SERVICE

Special two-man pickup service shall be provided on a "call" basis to persons desiring to dispose of individual items not exceeding two-hundred (200) pounds which cannot be collected by the regular collection vehicle, such as furniture, appliances, hardware, or other items approved by the Superintendent of Public Works. Persons desiring this service shall call the Public Works Department and give their name, address, and descriptions of item(s) to be collected. They will be advised when to set these items out. Items must be placed at the curbline or at approved alley location, so that City employees are not required to enter private property. Special pickup service does not apply to loose materials such as loose trash, loose garden trash, or industrial processing wastes.

APPENDIX 9.12 SAMPLE FOR CITIZEN NOTIFICATION

IMPORTANT ANNOUNCEMENT

CITY OF COVINGTON
COVINGTON, KENTUCKY

DEAR CITIZEN:

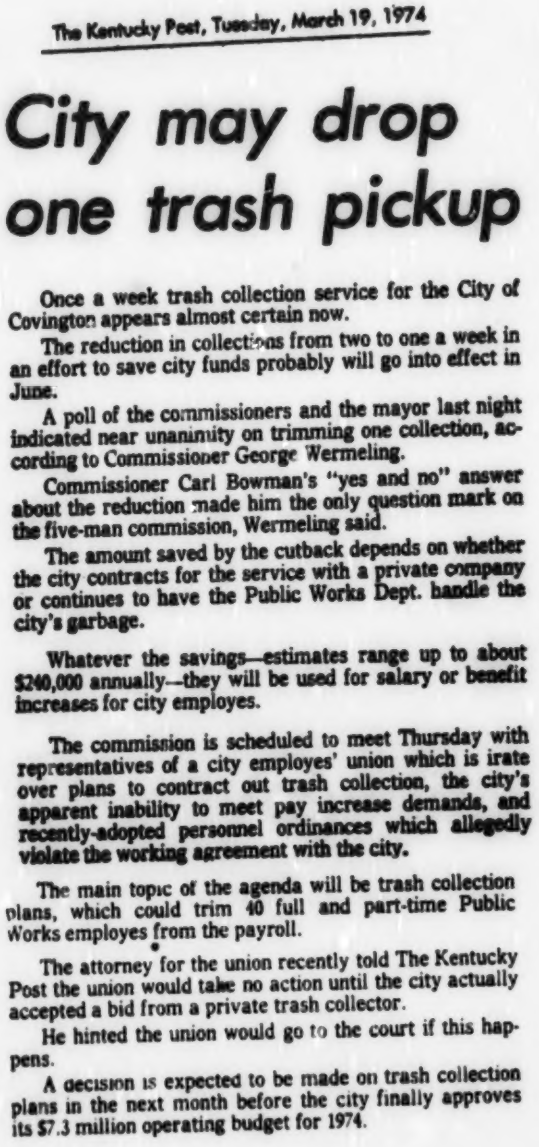
AS YOU MAY KNOW, THE CITY HAS BEEN WORKING FOR THE PAST SEVERAL MONTHS TO DEVELOP NEW WASTE COLLECTION ROUTES. THE INCREASED EFFICIENCY OF THE NEW ROUTES WILL ALLOW TWICE-A-WEEK COLLECTION FOR THE ENTIRE CITY, IMPROVED COMMERCIAL AND INSTITUTIONAL COLLECTION, AND LOWER OVERALL COLLECTION COSTS.

EFFECTIVE MONDAY, THE NEW COLLECTION ROUTES WILL BE IMPLEMENTED, THUS REQUIRING THAT EACH FAMILY DETERMINE THEIR "PICKUP DAYS." PLEASE TAKE A MINUTE TO DETERMINE YOUR LOCATION ON THE MAP (REVERSIDE SIDE), AND IDENTIFY YOUR SCHEDULED PICKUP DAYS. THIS INFORMATION WILL ALSO BE PUBLISHED IN THE NEWSPAPERS DURING THE WEEK OF

CERTAIN COMMERCIAL AND INSTITUTIONAL STOPS WILL BE NOTIFIED INDIVIDUALLY CONCERNING THEIR PICKUP SCHEDULE.

THANKS FOR HELPING IMPROVE YOUR CITY.

APPENDIX 9.13 EXAMPLES OF NEWSPAPER COVERAGE PRIOR TO COLLECTION ALTERNATIVE SELECTION



The Kentucky Post, Tuesday, March 19, 1974

City may drop one trash pickup

Once a week trash collection service for the City of Covington appears almost certain now.

The reduction in collections from two to one a week in an effort to save city funds probably will go into effect in June.

A poll of the commissioners and the mayor last night indicated near unanimity on trimming one collection, according to Commissioner George Wermeling.

Commissioner Carl Bowman's "yes and no" answer about the reduction made him the only question mark on the five-man commission, Wermeling said.

The amount saved by the cutback depends on whether the city contracts for the service with a private company or continues to have the Public Works Dept. handle the city's garbage.

Whatever the savings—estimates range up to about $240,000 annually—they will be used for salary or benefit increases for city employes.

The commission is scheduled to meet Thursday with representatives of a city employes' union which is irate over plans to contract out trash collection, the city's apparent inability to meet pay increase demands, and recently-adopted personnel ordinances which allegedly violate the working agreement with the city.

The main topic of the agenda will be trash collection plans, which could trim 40 full and part-time Public Works employes from the payroll.

The attorney for the union recently told The Kentucky Post the union would take no action until the city actually accepted a bid from a private trash collector.

He hinted the union would go to the court if this happens.

A decision is expected to be made on trash collection plans in the next month before the city finally approves its $7.3 million operating budget for 1974.

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APPENDIX 9.13, CONTINUED

The Kentucky Post, Tuesday, May 21, 1974

No city garbage strike; crews cut, not pickups

BY GREG PAETH
Kentucky Post Staff Writer

Members of the union which represents 200 non-uniformed Covington employes talked strike Monday night.

But Union Treasurer William Sturgeon said members finally voted by a "heavy majority" to accept a resolution reducing city sanitation crews from three to two men.

He refused to disclose the exact vote.

The resolution coincides with city commission decision which would retain twice-weekly garbage collections while trimming the size of sanitation department crews.

The union had supported retention of three-men crews with once-a-week trash collection.

"It's their ballgame, so we're playing with them," said Sturgeon.

Sturgeon said the union plan would have saved the city about $225,000. He said the city would realize savings of only $113,000 with the plan city commissioners favor.

Sturgeon criticized the two-man crew plan as being "unsafe," adding that "it probably won't work in this city."

The union treasurer, who works in the city's housing department, said final details of a contract agreement for the last half of 1974 are expected to be worked out Wednesday in city hall when the union meets with City Manager Paul Royster.

Contract talks have been stymied by uncertainty over the trash collection plan which would go into effect during the last half of the year.

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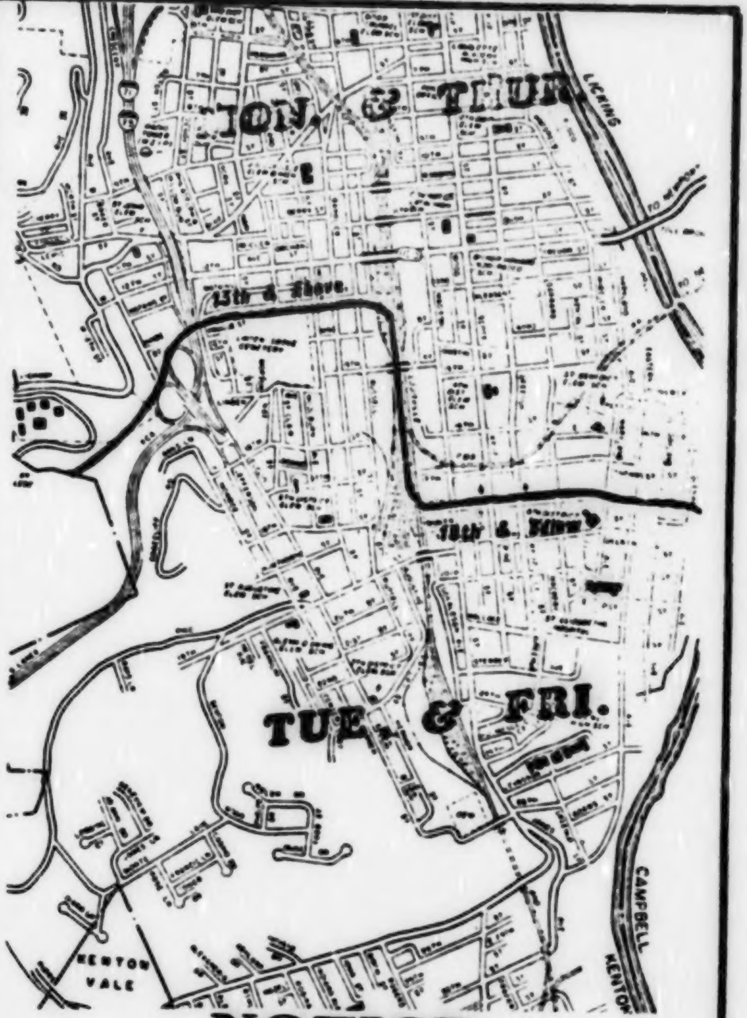
APPENDIX 9.14 NEWSPAPER CITIZEN NOTIFICATION PRIOR TO CHANGE OVER

The Kentucky Post, Saturday, August 3, 1974 9



NOTICE

ALL CITIZENS OF COVINGTON
TRASH COLLECTION SCHEDULE
RESIDENTIAL PICKUP
EFFECTIVE MONDAY, AUGUST 5, 1974

MONDAY AND THURSDAY PICKUP

All residences which lie WEST of the L&N RR track, and NORTH of 13th Street.

AND

EAST of the L&N RR tracks and ABOVE 18th Street, but not including 18th Street, will be collected on *Monday and Thursday*.

TUESDAY AND FRIDAY PICKUP

All residences which lie WEST of the L&N RR tracks and SOUTH of 13th Street, but not including 13th Street.

AND

all residences which lie EAST of the L&N RR tracks and on or below 18th Street, will be collected on Tuesday and Friday.

NOTE: For the time present alleys which have been in the past year receiving residential pickup will continue to receive residential pickup. As the new system becomes operational, additional alley pickup service may be available. Proper notice of such service will be given.

FINAL NOTE: This new system will begin Monday morning, August 5, 1974.

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APPENDIX 9.15 SUMMARY OF TEAM ASSIGNMENTS

CITY OF COVINGTON
DEPARTMENT OF PUBLIC WORKS
WASTE COLLECTION

	TEAM I	TEAM II
Foreman:	Johnson	Miller
Team Drivers:	Craddock	
	Hitch	Cain
	Klein	Findley
	Powers	Halbert
	Raper	Harris
	Stanley	Harris
		Sturgeon
Heavy User Drivers:	England	McQueen

Results of Team Assignments:

	Choices: +	Choices: -
Cain	4/4	
Craddock	2/4	4/4
England	3/4	3/4
Findley	3/4	3/4
Fischer	2/4	3/4
Halbert		
Harris	3/4	2/4
Hitch	3/4	3/4
Klein	1/4	3/4
McQueen	3/4	
Powers	3/4	3/4
Raper	3/4	
Stanley	2/4	4/4
Sturgeon		

Shupe/Shell
7/29/74

APPENDIX 9.16
CITY OF COVINGTON
DEPT. OF PUBLIC WORKS
WASTE COLLECTION

DRIVER GUIDELINES:

1) In case of breakdown, illness, or accident, call the Assistant Superintendent's Office immediately (292-2293, 292-2294).

2) Position truck close to setout.

3) Collect only one side of street per pass unless street is narrow (3 car widths or less) and little traffic.

4) Load packer as full as possible.

5) During trip to landfill, shift laborer to another truck in your team.

6) Help load at heavy setouts except where unsafe to leave cab.

7) Refuel truck at end of day.

8) ______________________________

9) ______________________________

10) ______________________________

APPENDIX 9.17
CITY OF COVINGTON
DEPT. OF PUBLIC WORKS
WASTE COLLECTION

FOREMEN'S ACTIVITIES

The foreman is a key person in the successful operation of the team initiative system.

Each team is responsible for a collection area on a given day under the direction of its foreman. The team member crews share the work load until the job is completed. No one leaves work until the team area is totally collected, unless permitted by the foreman.

The foreman's major activities include:

1) Assigning individual manpower and trucks within the team collection area, and requesting from the Assistant Superintendent substitute personnel as required.

2) Maintaining field contact with his truck crews through out the working day.

3) Coordinating field operations with the Public Works Office and the Assistant Superintendent.

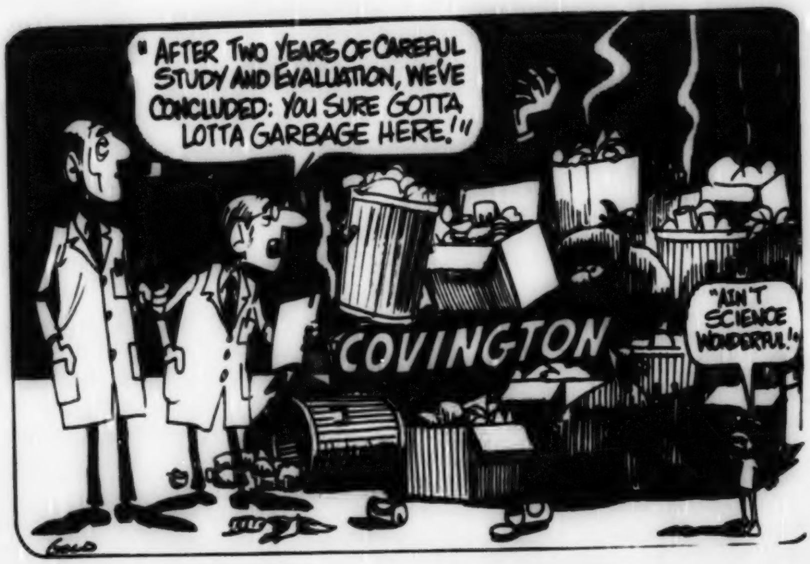
4) Responding to citizen complaints originating within his team's collection crews.

5) Inspecting solid waste containers set out for collection.

6) Condemning containers that are in violation of City Ordinance.

7) Initiating action on litter violations resulting from solid waste setout.

The Kentucky Post, May 15, 1974.


"AFTER TWO YEARS OF CAREFUL STUDY AND EVALUATION, WE'VE CONCLUDED: YOU SURE GOTTA LOTTA GARBAGE HERE!"
COVINGTON
"AIN'T SCIENCE WONDERFUL!"

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